February 2000

Seasonality of food consumption of poor households in Madagascar [1]

Benoît Dostie, Cornell University
Steven Haggblade, Cornell University
Josée Randriamamonjy, INSTAT[2]

[1]The views contained in this study are those of the authors and do not necessarily reflect those of the INSTAT, Cornell nor USAID.

[2] The authors would like to thank in particular, without implying their responsibility for the results, Paul Dorosh and Yazid Dissou for their advice in the development of our seasonal model, Dominique Waltisperger, who allowed us to present his very interesting data on the seasonality of mortality, and Abdullah Dustagheer for his observations on the seasonality of the nutritional state of the Malagasy population. Their comments and assistance were very useful to us in the preparation of this document.

FOREWORD

Poverty alleviation is one of the major objectives identified in the General Economic Policy Framework Document (Document Cadre de Politique Economique, DCPE) of the government of Madagascar. This objective will be achieved through multiple and concerted actions by economic and social development partners (public authorities, private sector, non-governmental organizations) at various levels - macro-economic, sectoral, regional, and even at the household and individual levels.

To date, the seasonality of poverty has never been discussed in Madagascar. Yet we know that the prices of basic food commodities show significant seasonal fluctuations, and we assume that the latter induce a visible fluctuation in food consumption level of vulnerable households. This paper discusses the issue of seasonality of food consumption and attempts to measure its importance and impact on vulnerable households.

Based on INSTAT data on the seasonal evolution of the prices of basic food commodities, consumption parameters estimated recently from the Permanent Household Survey (Enquête Permanente auprès des Ménages, EPM) data, and following recent field missions targeted at the markets of major substitutes for rice, such as cassava and maize, the authors of this study attempt to quantify household reactions to significant seasonal price movements. This analytical work is undertaken jointly by the National Institute of Statistics (INSTAT) and Cornell University, under financing of USAID.

I would like to thank the U.S. Agency for International Development (USAID) for the financial support it provided in completing this analytical work of utmost importance.

I hope that the analytical results will contribute to informing and helping decision-makers in their discussions and development actions in Madagascar.

Rajaobelina Philippe
Executive Manager of INSTAT

TABLE OF CONTENTS

TABLES

LIST OF FIGURES

LIST OF ADDITIONAL TABLES

ACRONYMS AND ABBREVIATIONS

AIDS	Almost Ideal Demand System (Système de demande presque idéal)
CAP	Commercial Agricultural Project
CFNPP	Cornell Food and Nutrition Policy Program
DCPE	Document Cadre de Politique Économique
EDS	Enquête Démographique et de Santé
EPM	Enquête Permanente Auprès des Ménages (1993) et Enquêtes Prioritaires Auprès des Ménages (1997 et 1999)
FMG	Franc malgache
FOFIFA	Centre national de la recherche appliquée au développement rural
GAMS	General Algebraic Modeling System
IFPRI	International Food Policy Research Institute
INSTAT	Institut National de la Statistique
MaDIO	Madagascar Dial Orstom
PADR	Programme d'Action de Développement Rural
PNSAN	Programme National de Surveillance Alimentaire et Nutritionnelle
SECALINE	SECurité ALImentaire et Nutrition Élargie
USAID	U.S. Agency for International Development

SUMMARY IN ENGLISH

Seasonal variation in food availability and prices induces noticeable reductions in food consumption and caloric intake among Madagascar's poor during the lean season. This compression in food intake generally becomes most pronounced between January and March, just before the major rice harvest. Rural households feel its effects most acutely since rural price movements roughly triple those in major urban centers. Because the seasonality of food shortages coincides with rising prevalence of sickness during the rainy season, when diarrhea is most acute, the lean season exacts a heavy toll in terms of increased rates of malnutrition and child mortality.

To compensate for spiking rice prices during the lean season, most poor households substitute cassava, tubers and, to a lesser extent maize, for rice. These secondary food crops provide an important seasonal buffer due to their more uniform availability and counter-seasonal price movements. Yet even after compensating with increased cassava and tuber consumption, poor households' caloric intake falls by about 12% during the lean season. Because of this, seasonal reductions in food consumption pull about 1 million Malagasy below the poverty line during the lean season.

This paper measures the probable impacts of three common seasonal food interventions: 1) seasonal income transfers to poor households; 2) rice imports during the lean season; and 3) increased agricultural productivity in key food crops. Income transfers prove most effective in the south of Madagascar, though prohibitively expensive as a general tool for seasonal poverty reduction. Rice imports target the urban poor effectively, though at the cost of significant foreign exchange outflows and reductions in incentives to domestic food producers. Investments in agricultural productivity appear most sustainable and effective over the long term, particularly when targeted at secondary crops such as cassava and tubers.

RÉSUMÉ EN FRANÇAIS

La variation saisonnière des prix et de la disponibilité alimentaires entraîne de notables réductions du niveau de consommation alimentaire et calorique parmi les ménages pauvres à Madagascar pendant la saison de la soudure. Cette compression de la consommation alimentaire se fait sentir le plus entre janvier et mars, juste avant la principale récolte rizicole. Les ménages ruraux sont ceux qui subissent le plus les pressions saisonnières, car l'amplitude des mouvements saisonniers des prix ruraux est trois fois plus élevée qu'en milieu urbain. Puisque la saisonnalité de la pénurie alimentaire coïncide avec l'arrivée des maladies pendant la saison pluvieuse, quand la diarrhée se propage au maximum, les taux de malnutrition et de mortalité infantile augmentent perceptiblement pendant la soudure.

Afin d'amortir les effets de la montée abrupte du prix du riz pendant la soudure, la plupart des ménages pauvres substituent le manioc, les autres tubercules et, à un moindre degré le maïs, au riz. Ces denrées alimentaires secondaires fournissent un amortisseur saisonnier important en raison de leur disponibilité plus uniforme et leurs prix en contre-saison par rapport au mouvement du prix du riz. Néanmoins, même avec cette hausse compensatrice de la consommation de manioc, tubercules et maïs, la consommation calorique totale des ménages ruraux pauvres baisse d'environ 12% pendant la saison de soudure. Par conséquent, les réductions saisonnières de la consommation alimentaire tirent approximativement un million de Malgaches en dessous de la ligne de pauvreté pendant la période de soudure.

Cet ouvrage évalue l'impact probable des trois interventions saisonnières courantes: 1) les transferts saisonniers de revenu aux ménages pauvres; 2) l'importation de riz pendant la période de soudure; 3) l'augmentation de la productivité agricole des denrées alimentaires de base. Les transferts de revenu se révèlent les plus efficaces dans le sud de Madagascar, mais ils sont extrêmement chers comme outil général de combat des pressions saisonnières. Les importations de riz ciblent les pauvres urbains efficacement, au prix de sorties significatives de devises et de réduction des incitations aux producteurs alimentaires locaux. Les investissements dans la productivité agricole semblent être les plus soutenables et efficaces à long terme, particulièrement quand ils ciblent les cultures principales secondaires comme le manioc et les autres tubercules.

1. OBJECTIVES

More than two-thirds of the Malagasy population eat less than 2,133 calories per day,[3] the established threshold to support a productive and normal life (Figure 1). Thus, by definition, they are poor.

Their situation – already difficult – worsens considerably during the lean season.[4] Important seasonal price movements of major food crops largely influence the effective income and consumption potential of households. Due to the reduction in consumption induced by this seasonal pressure, it is very likely that the rate of absolute poverty increases perceptibly during the lean season.

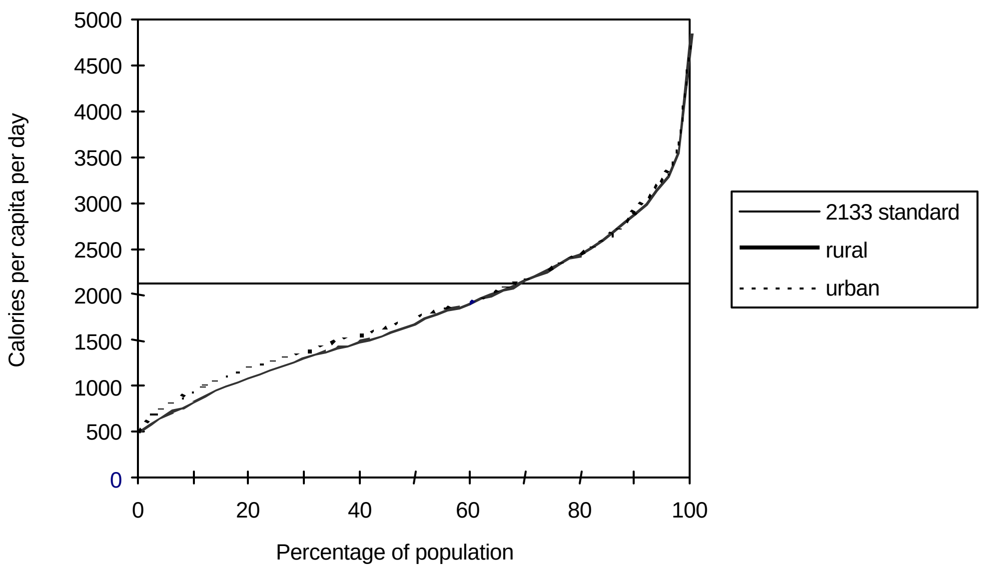
Despite the probable importance of the phenomenon, the seasonal fluctuation of poverty has never been measured in Madagascar. This study attempts to fill this gap. Our objectives include quantitative assessment of: (1) seasonality of food consumption and nutritional distress among the poor, and (2) efficiency of potential interventions to compensate for food insufficiency during the lean season.

These objectives are discussed in the following three chapters. The first chapter summarizes current knowledge on the seasonality of food distress in poor households. This requires a summary of seasonal variations in prices, production, and consumption of major food crops in Madagascar. Seasonal trends are also confirmed through certain physical welfare measurements including anthropometry and mortality of young children. The second chapter is focused on seasonal consumption quantification. Due to lack of representative seasonal data at the national level, this work requires the development of a seasonal model to measure intra-annual fluctuations in food quantity and eating patterns of poor households. Based on the multi-markets seasonal model, the analysis in the following chapter assesses the impact of buffer interventions on the welfare of poor households during the lean season.

[3] SECALINE (1997) suggests a standard of 2,133 calories per day. See Lapenau, Zeller and Ralison (1998) for further discussion on the calculation of nutritional standards.

[4] See Chambers (1981) for a general discussion on seasonal problems observed elsewhere.

Figure 1 – Food poverty in urban and rural areas in Madagascar, 1993/94



Source: Calculations based on EPM survey, 1993/94

2. CURRENT KNOWLEDGE ON SEASONALITY AND SEASONAL DISTRESS OF POOR HOUSEHOLDS

A. Production and storage

Agriculture is characterized by strong seasonal variations in production, marketing and prices. Consequently, basic food consumption follows a highly marked seasonal rhythm. As regards the household food ration, the most important food crops are rice, cassava, other tubers and maize. In caloric terms, rice contributes for more than 50% of the average caloric ration in the country (see Table 2), but the contribution of tubers and roots is not negligible. Cassava, the second food crop in Madagascar accounts for 14% of caloric ration on average and 25% among poor households in the south. The other tubers come in third position, accounting for 8% of the caloric ration. Despite the increasing importance of potatoes and sweet potatoes in recent years, cassava still predominates in the tubers and roots group. Maize arrives in fourth position with 7% of calories at the national level. Its position appears nevertheless very important in the south of Madagascar, a highly vulnerable region due to water insufficiency and periodic droughts, where maize accounts for 20% of caloric intake. In general, the poorer a household is, the more it relies on secondary crops (cassava, other tubers and maize) in its food intake.

1. Rice

Several studies have focused on the seasonality of rice production, marketing and prices, which are generally well understood.[5] In short, Madagascar typically experiences two main seasons: a dry season and a rainy season. Rice is sown at the beginning of the rains, around November, and the annual harvest takes place between March and August, with a peak period in May when the rural price of rice is lowest. At the onset of the rainy season, when work in the rice field for the next season begins, rice stocks begin to run out. The price of rice and most food crops begins to rise. The rice price remains high until the next harvest, with a peak observed in February and March.

2. Cassava

Given that cassava is the main substitute for rice, cassava and rice are expected to show similar seasonal price movements. Moreover, rice in the form of paddy and dried cassava can both be stored. Therefore, storage decisions of merchants are very important for price determination throughout the year.

However, unlike rice, cassava may be consumed fresh or dry, giving producers a wider choice at harvest time (CARE, 1997). Nevertheless, most of the drying takes place during the cold months, climatic conditions permitting, since the presence of a hot and dry period is the

[5] For instance, see Ahlers et al. (1984), Azam et Bonjean (1995), et Minten et al. (1997).

major seasonal constraint for dry cassava production (Dostie, Randriamamonjy and Rabenasolo 1999).

3. Storage

Decisions regarding the quantity of cassava to be dried and stored obviously depend on the anticipated prices. In the case of rice, it was demonstrated that the price increase from one month to another is generally sufficient to justify storage (Azam and Bonjean (1995). Barrett (1997) even maintains that increased inter-seasonal storage would help to stabilize the price of rice. No similar study has been undertaken for cassava, or for other basic food crops.

B. Seasonal price movements

1. Urban prices

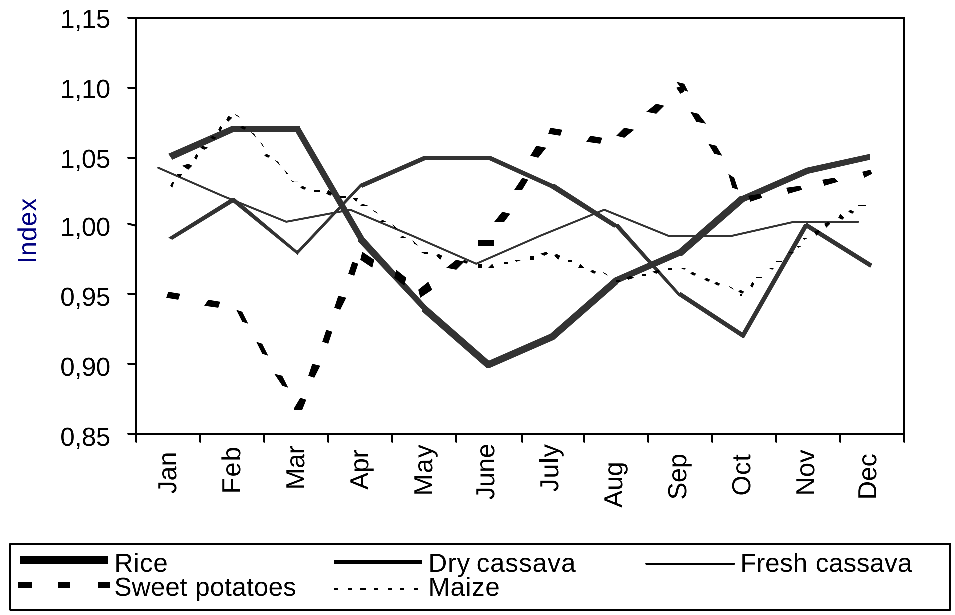
In order to trace seasonal price movements, we assembled the monthly data collected by the National Institute of Statistics (INSTAT) of Antananarivo during the last decade. In order to purge data of long-term trends, which are often very inflationary, a regression of prices based on the time variable was completed. This allows to separate long-term trends from seasonal movements. The indices calculated represent the monthly evolution of prices in real terms as deviation from the annual average. The results are presented as seasonal indices of the movements of major commodity prices (Figure 2).

We notice that the rice price is highest during the lean season, in February and March, just before the first harvests. With the first arrivals of rice from the various regions of Madagascar, the price gradually falls to reach its lowest level in June. The seasonal price increase (lean season price minus harvest season price) is approximately 17% in urban areas of the capital (Figure 2).

The seasonal price movement for dry cassava shows a shifted curve compared to that of the rice price. The dry cassava price rises beginning from March (when the rice price falls) and is highest in June (when the rice price is lowest). When winter comes, the convergence of the dry weather with the availability of labor allows farmers to dry cassava and sell it on the market. Therefore, the cassava price goes down throughout the winter and rises at the beginning of the lean season, when the first rains prevent drying. The cassava price movement is thus shifted compared to rice. Owing to this difference, the relative price of rice compared to dry cassava rises during the lean season. This relative price change encourages poor households to substitute cassava for rice in their diet.

The movement is different from that of fresh cassava, which shows no distinct seasonal trend. This is very likely since fresh cassava can be kept in the ground for a long time if necessary: its price therefore remains stable throughout the year.

Figure 2 – Seasonality of the prices of key food crops in Antananarivo (1988-1998)



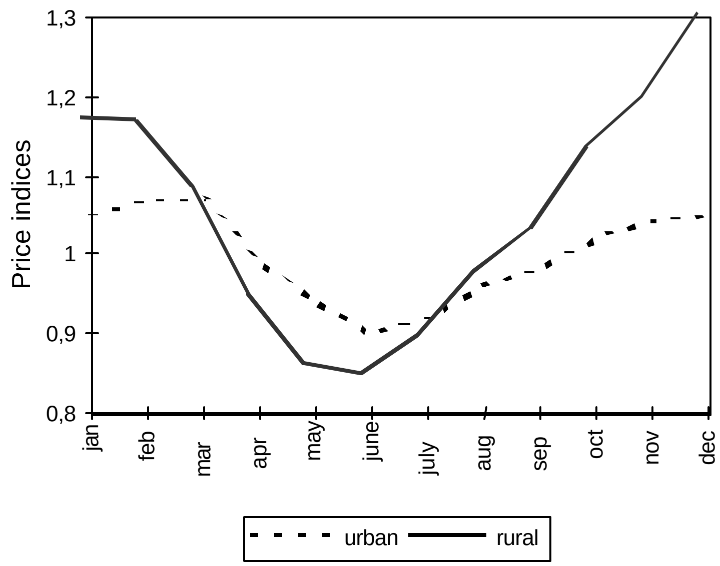
Source: Calculations based on INSTAT data, Prices Department

As regards other secondary products, Figure 2 shows that price movements for maize and rice have many similarities. On the other hand, the sweet potato price seems to show seasonal impacts opposite to rice. This will have significant implications during the lean season since vulnerable households will rely more on sweet potatoes during the difficult months preceding rice harvest, given that the sweet potato price is lowest at a time when rice is rarest.

2. <u>Rural prices</u>

Seasonal price movements of food crops are more acute in rural area. The seasonal movement of the rice price in urban Antananarivo is estimated at 17%, while the seasonal rise in rural areas is around 45%, i.e. almost three times higher (Figure 3). This wider movement in rural areas is confirmed by recent studies by Minten et al. (1997), Barrett (1996) and USAID CAP Project. The moderate rise in urban areas is due to the seasonal change of supply sources in the large cities. Thus, the seasonal pressure of price increase is less felt in urban area.

Figure 3 – Seasonality of urban and rural rice prices in Antananarivo



Source: INSTAT and MinAgri.

While the seasonal rise is more pronounced in rural areas, seasonal trends do not show any significant difference in the seasonal price patterns of rural and urban areas. Harvest impacts are felt one month earlier in rural area, the time needed to convey the new production into the cities. For the same reason, rural price starts to go up one month earlier. Except for this small difference, urban and rural price trends are quite similar (Figure 3).

3. Increasing importance?

A study on food prices by Minten (1998) shows that the seasonal price variation of most of the basic commodities has increased since the liberalization of agricultural markets at the beginning of the 80s.[6] Although limited to the capital city, the study includes several interesting results. It explains that the increase in seasonal variation of prices is due to two factors: the direct impacts of liberalization and the increasing importance of transport costs.

[6] Barrett (1997) comes to the same conclusion.

C. Seasonality of consumption

During the lean season, the study of the evolution of food welfare shows a general and variable decline in the level of food consumption. As a consequence, households react by substituting tubers and other cereals for rice in their diets. The substitution is generally more important in the south than in the north and in rural areas than in urban areas (SECALINE 1996).

The quantification of these seasonal changes – consumption decline and food substitution rates in household consumption – is nearly non existent in Madagascar. The only empirical literature available is a survey undertaken by the International Food and Policy Research Institute and the National Center for Research Applied to Rural Development (Centre National de Recherche Appliquée au Développement Rural, IFPRI/FOFIFA) among Malagasy agricultural households in some regions of the island in 1996-97. Twice during the year - with the first mission during the dry season and the second mission during the rainy season - interviewers estimated the shares of various food groups in household consumption. The survey shows that caloric intake generally falls in the rainy season (Table 1). The decline is estimated at 4% in the rural areas of Fianarantsoa, whereas it is only 2% in the rural areas of Majunga. While tubers serve as a seasonal buffer in the High Plateaus, rice is mostly substituted by maize in Majunga.

It seems impossible to generalize these results to other regions based on empirical data available. Except for the IFPRI/FOFIFA study mentioned in Table 1, to our knowledge, the seasonality of household consumption has not been quantified in Madagascar, either by omission or voluntarily as it makes temporal comparisons more complicated. In fact surveys on household welfare monitoring often avoid introducing seasonal variations intentionally.[7] In order to exclude long-term trends and not to confuse them with seasonal movements, consecutive household surveys always target the same seasons. Such a precaution is certainly necessary to draw out long-term trends. Yet it leaves us with a poor documentation on the amount of seasonal fluctuations in household consumption.

Table 1 – Caloric intake per season in four rural areas in Madagascar

Region	Total calories consumed per adult equivalent per season			Change in caloric composition (part mission 1 - mission 2)		
	mission 1	mission 2	difference	Rice	Other Cereals	Tubers
Fianarantsoa Highlands	2738	2357	-14%	-14%	1%	20%
Ranomafana	2613	2353	-10%	-11%	1%	9%
Majunga Highlands	3240	3172	-2%	-7%	4%	2%
Majunga Plain	2906	2782	-4%	-10%	10%	-6%

Source: Lapenu, Zeller and Ralison

[7] This appears to be the case with EDS and EPM surveys and rural observatories of the Madio Project.

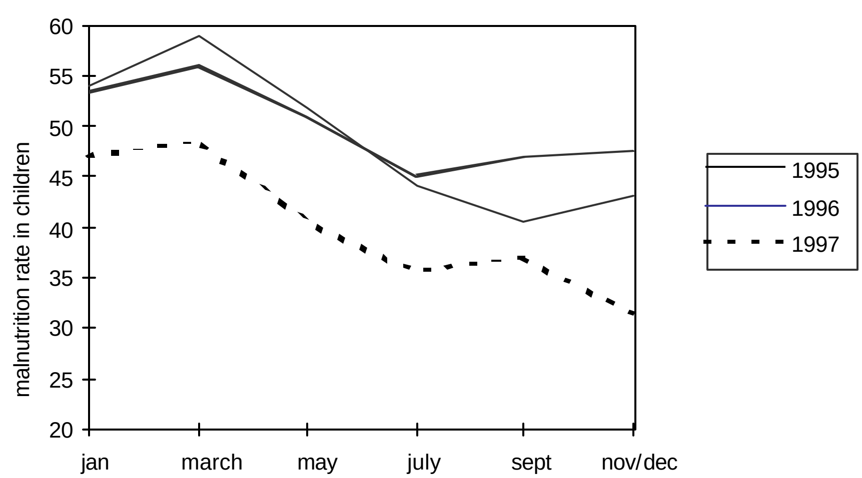
D. Seasonality and anthropometric measures

The seasonality of production, prices and consumption has real repercussions on people's health. Underweight as measured by the weight/age ratio is widespread - according to EDS survey, 40% of children are affected - and sensitive to seasonal variations.

Furthermore, several anthropometric measurements collected by the National Programme on Food and Nutritional Monitoring (Programme National de Surveillance Alimentaire et Nutritionnelle, PNSAN) of the Ministry of Scientific Research show a significant increase in malnutrition rate during the lean seasons. Figure 4 shows that malnutrition rate in the Brickaville areas was 15% higher during the lean season than it was at harvest time. PNSAN intervention in these regions improved the food and nutritional situation, on average, over one year. However, it does not alter the pattern of seasonal fluctuation.

Several factors combine to significantly increase the child malnutrition rate during the lean season. The insufficiency of food supply is aggravated by the rising prevalence of diseases such as diarrhea and malaria, which worsens the situation since the lean season coincides with the rainy season.

Figure 4 – Seasonality of manutrition in children under 5 (11 sites in Brickaville)



Source: PNSAN (1997).

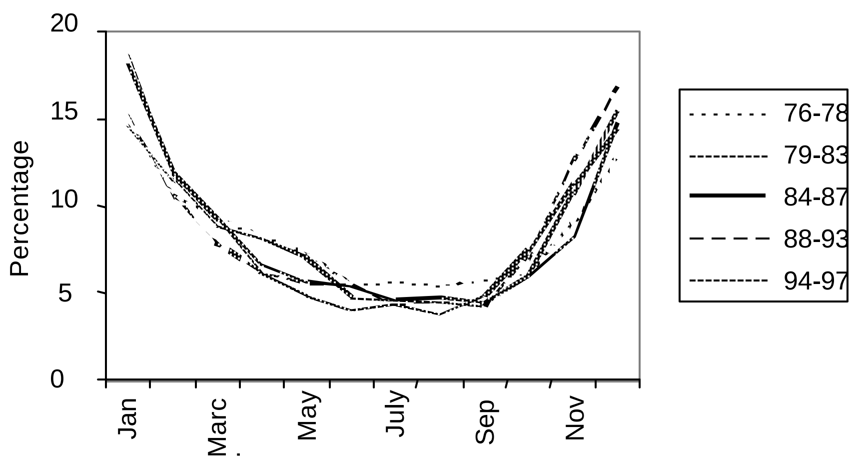
E. Mortality

Data on mortality recently collected in Antananarivo underline the seriousness of the seasonal distress which affect households.[8] The monthly distribution of deaths confirms the severe conditions prevailing during the lean season. According to EDS, the infant mortality rate is 5,6 % in Antananarivo. But this mortality is highly concentrated during the lean season, especially in December and January (Figure 5).

The main causes for infant mortality are, by order of importance, diarrhea (26% of deaths) which is closely followed by malnutrition (22%), then by pneumonia and other respiratory infections (13%) and measles (6%) (Waltisperger, 1998). The interactions between malnutrition and diseases make the attribution of the main cause more complicated. If we consider these interactions, malnutrition appears to be even more important; it is the most important of the secondary causes of infantile deaths (Waltisperger et al., 1998, Table 14).

In urban areas, where seasonal price movement is not significant, the variation of mortality is already noticeable. Comparable literature does not exist for rural area. However, if we consider the amplitude of seasonal variation of price movements, which is three times higher in rural area, the situation can be expected to be much more serious for the rural poor during the lean season.

Figure 5 – Monthly distribution of mortality in children aged 1-4 years in Antananarivo



Source: Waltisperger[8].

[8] Dominique Waltisperger, of the Institut Santé et Développement at Pierre and Marie Curie University (Paris VI), completed this study in the context of the production of his important book "Mortality in Antananarivo from 1984 to 1995 " (Waltisperger et al, 1998). His analyses are presented in Figure 5 with his kind permission.

3. QUANTIFICATION OF VARIATION IN SEASONAL CONSUMPTION

A. Background data

To our knowledge, there are no representative data on the seasonality of food consumption at the national level in Madagascar. Except for the recent study undertaken by IFPRI/FOFIFA, which traces the evolution of consumption of the same household group twice during the year in four rural areas, household monitoring studies generally avoid introducing the seasonal element for fear of distorting long-term trends. They are right in their concern to differentiate seasonal tendencies from long-term ones.

Due to the lack of representative data on seasonal consumption of the various household groups in Madagascar, we had to estimate this variation using the known elements: i.e. the annual average consumption of the various household groups, the seasonal fluctuation of the prices of key food crops, and the household behavior vis-a-vis income and price fluctuations. Fortunately, all three elements are available. The profile of annual average consumption is readily available from the EPM survey (INSTAT, 1995). Seasonal price movements were provided by the Prices Department of INSTAT and the Ministry of Agriculture. Supply elasticities have just been estimated in a recent INSTAT study (Ravelosoa et al., 1999).

Using these basic elements, we could build a seasonal model to assess the seasonal change in food consumption of the various household groups in Madagascar. The development of such a model was necessary to this end. Furthermore, this necessity has a considerable advantage. Not only does the model estimate the fluctuations of seasonal consumption but also it subsequently assesses the impact of the various interventions on the seasonal consumption level. It therefore becomes an assessment tool for potential interventions.

B. Characteristics of a seasonal model

1. Objectives

Our seasonal model was developed with two objectives in mind including:

- quantitative assessment of the seasonality of food consumption and caloric intake of poor households;
- efficiency assessment of potential interventions which might reduce seasonal food poverty.

To this effect, it was necessary to introduce the following desegregated structure:

2. Structure of the seasonal model[9]

a. seasons

Six seasons are identified in the model to reflect significant fluctuations of prices (Figure 2 and 3) and vulnerable household consumption throughout the year. To simplify the task, the model divides the year into six periods of two months each. Thus, T1 includes January and February, T2 March and April, and so on until T6, which includes November and December. Later we will see that T1 (January and February) is the peak period of the lean season and therefore the most difficult season for poor households.

b. regions

A regional division was also necessary considering the highly variable consumption structure in the different regions (Table 2). The difference between the South and the rest of the country is particularly marked. Unlike the rest of the country, cassava and maize are the most important food crops in the South where in caloric terms, rice comes only in third position. Elsewhere, rice is in the leading position accounting for more than half of the calories consumed.

Rural areas in the rest of the country are also different from urban areas. In rural areas, cassava, other tubers and maize are more important than in urban areas. These secondary products account for 24 to 33% of calories in rural areas compared 8 to 19% in urban areas (Table 2).

In order to reflect such differences, the seasonal model divides the country into three regions: the South, rural areas in the rest of the country, and urban areas.

c. households

Several socioeconomic groups are identified in each region based on income, food preferences and consumption structure. Therefore, a division of households is necessary within each region, since both the behavior and consumption structure of poor consumers differ from those of rich households.

In urban areas, poor households consume more calories from rice (60% vs. 54% among the richer) and from secondary products like cassava, other tubers and maize (19% vs. 8% for rich households). In contrast, rich households consume more than one-third of calories from meat, fruits, vegetables, milk and other de luxe food products for only 22% among the urban poor. In addition, rural poor rely more on secondary products – cassava, other tubers and maize – and less on de luxe food products. We therefore know that such differences lead to different behavior in different household groups (Ravelosoa et al. 1999).

In terms of caloric intake, poor households consume far fewer calories than rich households, i.e. 25% less on average (Table 2). On average, poor households fall below the

[9] The model was based on a similar model developed by Paul Dorosh for Bangladesh (Dorosh and Haggblade, 1997). However, it was modified in many aspects to adapt it to Madagascar's case.

established threshold of 2,133 calories per person per day (Minten and Zeller, 1999). Thus, in order to target the evolution of the welfare of poor households, they should necessarily be separated from the non-poor households in the study. Thus, we have 6 household categories, the poor and the non-poor in each of the three regions of the country.

d. *products*

The model identifies seven different products, the main commodities -. rice, fresh and dry cassava, maize, and other tubers – and a set of other food products (meat, vegetables, fruits, milk, oils, etc.) and non-food commodities. The distinction is necessary to reflect key substitutions of rice by its main substitute products, namely cassava, other tubers and maize. The distribution of the main caloric sources allows us to follow the evolution of household caloric intake.

Table 2 – Structure of caloric intake by household group

		Rural households				Urban households	
	National	South		Rest of country			non
Consumption	total	poor	rich	poor	rich	poor	poor
Quantity (kg per capita per annum)							
rice	117	42	59	107	154	123	129
cassava	69	85	149	73	80	43	16
other tubers	42	28	55	53	41	26	17
maize	15	45	60	12	13	8	6
other products	251	251	408	149	298	232	563
total	494	450	730	394	587	431	732
Calories (percentage)							
rice	52%	21%	20%	53%	56%	60%	54%
cassava	14%	25%	28%	16%	12%	10%	3%
other tubers	8%	6%	8%	11%	7%	5%	2%
maize	7%	23%	20%	6%	5%	4%	3%
other products	20%	23%	24%	15%	20%	22%	37%
total	100%	100%	100%	100%	100%	100%	100%
Total calories per person per day	2,157	1,869	2,888	1,920	2,611	1,963	2,279

Source: Calculations based on EPM survey 1993/94.

3. Behavior

a. consumption

The total consumption of the seven items is the sum of household and animal consumption (particularly significant for cassava) and exports. The last two elements, i.e. animal demand and exports, are considered to be fixed and exogenous to the model. In other words, these two components are dependent on the animal population, the exchange rate and international market trends respectively, which are exogenous elements to our seasonal model.

The consumption of each household group varies according to income and product prices. Demand elasticities are different for the six household groups to reflect significant behavior differences of the various household groups. The elasticities used are those recently estimated by INSTAT (Ravelosoa et al. 1999). The functional form used in the seasonal model (see Appendix A, equation 1) simplifies consumer behavior by keeping demand elasticities constant.

Household income, which determines the purchasing power, is calculated as the sum of three elements: agricultural income (Yag), non-agricultural income (Ynonag) and transfers (Ytfrts). While agricultural income varies according to agricultural prices, non-agricultural income and transfers are considered exogenous (see Appendix A, equation 2).

g. supply of goods

The supply of goods comes from three major sources: domestic production, imports and sales of existing stocks. Each element is modeled as a function of the price of the commodity. Precise functional forms and response elasticity are presented in appendix A (see equations 4 to 6 and Table a.5).

4. Balance

In the event of a shock, the six food markets counterbalance each other through price, which rises or falls in order to balance supply and demand. In contrast, non-food commodity price is fixed at one. It therefore becomes the numeraire of the model. Non food commodity, with a fixed price, is balanced through adjustment of imports.

Urban and rural prices fluctuate in parallel with a fixed margin, which ensures the connection between the two prices. To reflect the reality of seasonal fluctuations - which are three times more acute in rural area than in urban area - in the model (Figure 3), the margin varies from one season to another.

5. Shocks and impacts

Without shocks, the model traces the movement of household consumption through the six periods of the year. The normal seasonal price movement involves a change in the composition of the consumption basket of the various household groups, leading usually to a significant variation of caloric intake. (Figure 6).

From this basic curve, the model makes it possible to measure the seasonal impact of a range of shocks. The main shocks measured in the following analyses are those most likely to contribute to a reduction in the nutritional distress of poor households during the lean season. Three shocks are considered : a) an increase in agricultural productivity of various food crops; b) an increase in food imports; and c) a transfer of seasonal income to vulnerable households. The first two shocks affect the supply of basic commodities. The third affects demand and purchasing power of poor households.

The impacts of these different shocks are measured on the basis of the seasonal movements of prices, production, income, and food consumption and caloric intake of the six household groups. Particular emphasis is laid on impacts on poor household caloric intake during the lean season.

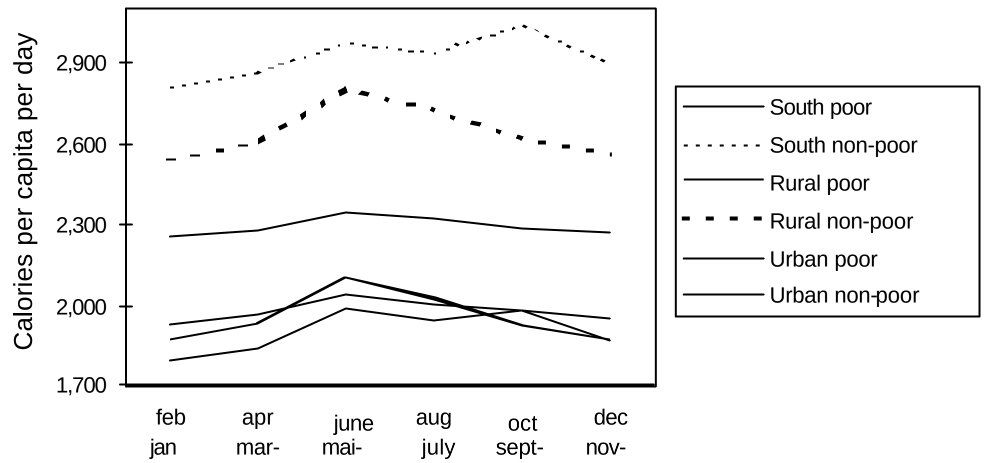
C. Seasonal consumption

Due to lack of representative background seasonal data at the national level, the movement of household consumption is traced through the six periods of the year as a function of seasonal price movements. This variation involves a change in the composition of the consumption basket of the various household groups leading to a variation of caloric intake (Figure 6).

This "normal" seasonal curve shows some similar tendencies for the six household groups. The lean season involves a decline in consumption level for all household groups. The decline is estimated around 10% for rural households and 5% for urban households. The most severe impacts are felt in January and February everywhere. On the other hand, in May and June, the post rice harvest period, the rapid fall in rice price (Figure 2 and 3) results in a significant rise in caloric intake of households.

Consumption composition also changes. During the lean season, we observe a significant reduction in rice consumption and an important substitution for secondary products, cassava in particular (Table 3).

Figure 6 – Seasonality of caloric intake by household group



Source: Basic simulation of the seasonal model.

Nevertheless, significant contrasts are observed between poor and rich households. For rich households, average consumption never falls below the minimum nutritional threshold of 2,133 calories per person per day. Even during the lean season, rich households eat well.

On the other hand, poor households are generally in difficulty. Their diets do not provide sufficient calories to support a normal and active life. It is only after the rice harvest, in May and June, that they can eat close to the nutritional threshold owing to the important fall in the rice price. On the other hand, during the lean season, poor household consumption declines significantly. Caloric intake of the rural poor declines by 12% during the lean season compared to the level observed at harvest time (Table 3). Among the poor households in the south, the seasonal caloric decline is estimated around 11%. For poor urban households, a less serious decline of just 5% is observed due to the rice price variation, which is less acute in urban environment (see Figure 3).

The southern region presents two differences from the rest of Madagascar. First, the disparity between rich and poor is more important in that region (Figure 6). In the South, the caloric differences between rich and poor exceed 1,000 calories per day, compared to 700 in rural area elsewhere and 400 in urban area (Table 2). Secondly, the seasonal consumption curve has a different form in the South. The most difficult period remains the lean season, in January and February. But the easiest season for consumers, rich and poor, occurs in October and September, not in May-June as elsewhere. In the winter, dry cassava is sold in large quantities on the market and reaches its lowest price at the beginning of spring. Considering the importance of cassava in the South, this leads to increased caloric intake in September and October.

D. Issues

During the lean season, in spite of the compensatory impact of the seasonal increase in the consumption of cassava, other tubers and maize, poor households are still affected by a strong decline of their caloric intake level. By definition, this is translated by an increase in the level of seasonal poverty. In fact, our basic simulations, with the distribution observed in Figure 1, allow us to measure the seasonal change in the incidence of poverty in Madagascar. As shown in Figure 7, the incidence of poverty in rural areas varies from 64% after harvest time to 72% during the worst phase of the lean season, i.e. in January and February. Thus, 8% of the population in rural areas, i.e. 900,000 Malagasy, are victims of seasonal poverty.

Fluctuations are less important in urban areas owing to a less pronounced seasonality of urban prices. For this reason, only 4% of urban citizens are seasonally poor. Yet we should bear in mind that despite the weak seasonal pressure in urban areas, a small fluctuation in seasonal prices involves an acute rise in the rate of infant mortality. Issues are certainly more serious in rural areas due to a marked compression of the level of consumption.

Table 3 – Food substitutions during the lean season, Madagascar 1995

Household	Total caloric intake per season			Change in caloric composition Part lean season- harvest				
	harvest	Lean	difference	rice	cassava	other tubers	maize	other food
Rural households								
South poor	1.979	1.790	-10,6%	-13,3%	7,2%	2,4%	6,5%	-2,9%
South non-poor	2.975	2.810	-5,9%	-13,3%	6,6%	2,4%	4,8%	-0,8%
Rest of country poor	2.103	1.873	-12,3%	-8,4%	4,3%	4,1%	1,6%	-1,5%
Rest of country non-poor	2.804	2.540	-10,4%	-6,4%	2,6%	2,5%	1,2%	0,2%
Urban households								
poor	2.033	1.932	-5,2%	-1,4%	1,0%	0,8%	0,4%	-0,7%
non-poor	2.343	2.252	-4,0%	-1,3%	0,2%	0,4%	0,2%	0,5%

Source: Basic simulation of seasonal model

Figure 7.a – Seasonality of caloric intake in rural areas, Madagascar 1993/94

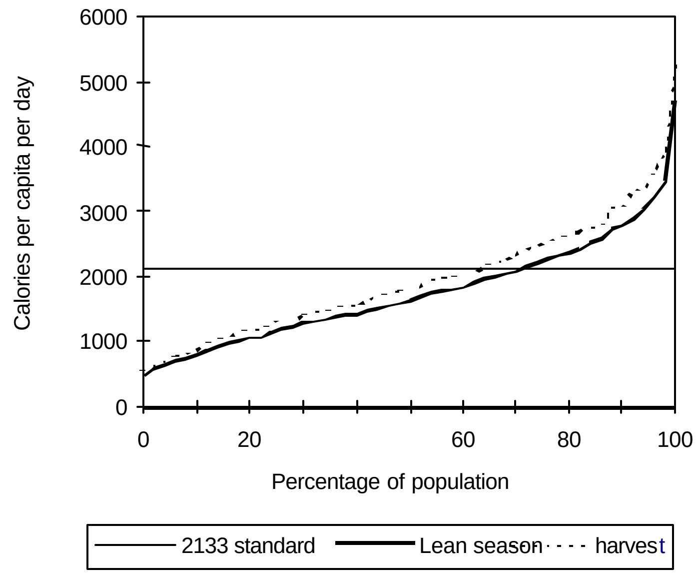
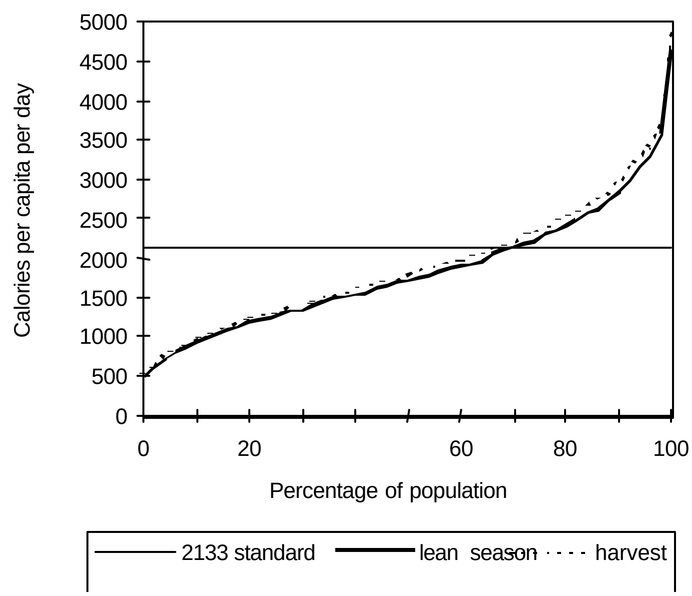


Figure 7.b – Seasonality of caloric intake in urban areas, Madagascar 1993/94



Source: Calculation based on caloric distribution in the EPM survey and basic seasonal simulations of the seasonal model.

4. INTERVENTIONS

A. Interventions considered

1. What shocks?

Three categories of common interventions designed to increase food consumption of vulnerable households during the lean season are discussed. Depending on their economic impact on poor households, interventions are classified as follows: 1) seasonal income transfers targeted to poor households to increase purchasing power and food demand; 2) key food imports aimed at increasing supply, reducing prices and making basic food commodities cheaper; 3) increasing agricultural productivity which will increase rural household income and reduce cost for consumers.

The first category has a direct impact of the effective demand of poor households. The objective of income transfers to vulnerable households is to increase the latter's purchasing power, and consequently food consumption. At the global level, the largest seasonal interventions fall into this category. The most important programs include the Seasonal Work Program of Maharastra State, India which employs 500.000 people monthly during the lean season (Ravillion, 1991) and the large seasonal work programs in Bangladesh (Dorosh and Haggblade, 1997). In Madagascar, similar programs (although small-scaled compared to Asian programs) of specific public works -- against food and payment in cash – exist periodically in the South and in regions affected by cyclones and other natural disasters.

The second category of food programs comes in direct contrast, affecting only basic food supply. The objective is to reduce basic food commodity prices through imports. The large program on rice imports and price control of BULOG in Indonesia is one traditional example (Timmer, 1997). The buffer stock of Madagascar also falls into this category.

In the third place, we will discuss public investments intended to increase agricultural productivity. Investments may take several forms. They typically include agricultural research, but efforts may also include investments in agriculture extension systems, provision of improved inputs, and investments in road construction which make it possible to bring improved fertilizers and to facilitate low-cost evacuation of rural production. Whatever the cause, increasing agricultural productivity has an impact both on the prices of basic foods and on income increases of rural agricultural households. This intervention strategy falls into the category of interventions suggested by Mellor and Johnston (1984) and implemented in many Asian countries which gave rise to the Green revolution in Asia (Herdt and Capule, 1983). The new Action Plan for Rural Development (PADR) in Madagascar works in this direction to reverse the decreasing agricultural productivity trend in Madagascar.

Among possible interventions, we do not attempt to assess actions related to disease control, nutritional education, water quality and general public health issues. Given the importance of diarrhea in child welfare reduction during the lean season, such public health activities are as important as actions aiming at nutritional sufficiency (WHO, 1999; Pinstrup-Andersen et al., 1999). Such an effort would require data and analysis tools, which are very different from those used in the present study. Furthermore, it would probably be necessary to collect raw data during the interventions and to monitor households for an impact assessment of medical interventions. We wish that someone else would conduct such a study. An impact assessment of such interventions would be complementary to investigations initiated in this study on the food aspect of the seasonal problem affecting poor households.

2. Which amount?

Ideally, shocks would be standardized according to the equivalent public funds necessary to provoke them. In the first two simulations, this is more or less feasible. We arbitrarily started with an increase equivalent to 100,000 tons of rice, which is the quantity of rice imports in 1995 (Table a.1). For imports (simulation 2), purchase costs were calculated based on the global market and transportation cost and we assume that the government will recover two-thirds of the total costs from the sale of 100,000 tons of rice. Thus we value the net cost for the public treasury at one third of total import costs. For income transfers (simulation 1), we distributed the same amount to the 2 million poor households in Madagascar.[10] This will lead to a 5,6% increase in annual income on average. This amount was transferred to them during the lean period, in January and February.

For the last three simulations, which increase agricultural productivity, equivalence becomes more complex. In fact, we do not know the cost of agricultural research or extension expenditures necessary to improve rice, cassava and other tuber production.[11] Quantitative equivalencies were used due to lack of data on future investment profitability in agricultural research. For rice production (simulation 3), we consider a rise of 100,000 tons, i.e. 6,3% of national production in 1995, and the same amount used for imports (simulation 2). Although the costs involved in achieving such a result might be very different from import cost (probably much less expensive), the quantitative equivalence has the advantage of standardizing shocks, which allows us to draw similarities and differences in terms of results. For the other two basic commodities, cassava (simulation 4) and other tubers (simulation 5), we finally adopted a value equivalence of 100,000 tons of rice. In 1995 prices, this equivalence means 265,000 tons of cassava and 147,000 tons of other tubers. If increased cassava and other tubers production was achieved at lower cost than rice, it would have been necessary to increase shocks for tubers. But since we do not know how much this will cost, we only present standardized shocks in production value. This means that we can only compare change directions for various simulations but not their absolute amounts, since the latter are not comparable. With this precaution, we proceed to the results of the impacts of shocks on the food market and the caloric consumption level of vulnerable households.

[10] Approximately 70% of the 14 million population fall below the poverty line in Madagascar. These 10 millions Malagasy, for an average family of 5, represent about 2 million households.

[11] Goletti and Rich (1998) and Roubillard (1998) conducted an assessment study for rice in Madagascar. For a summary of results, see IFPRI/FOFIFA (1998). To our knowledge, no study was undertaken for cassava or other tubers.

B. Impacts on poor households

1. Seasonal income transfers to poor households: increasing demand

The intervention directly targets the income of poor households. It involves an increasing consumption of basic commodities, and consequently caloric intake of households. Currently, we simulate the impact of a rise of 5,6% in poor households' income, distributed during the lean season (January and February).

The rise in income during the lean season increases food consumption of recipient households. As a consequence, caloric intake of poor households increases by 2,6%, on average (Table 4). Households in the South benefit most from the increase. Considering their food preferences, which favor cheapest caloric sources (cassava and maize), they manage to increase their caloric intake up to 4,1%. Therefore, this kind of intervention has a maximum impact when targeting the South.

In terms of national food safety, the intervention's contribution is low compared to the other interventions (Table 5). It results in a slight rise in prices of basic food crops, which encourages a rise in national production and imports of tradable goods such as rice and maize. However the total response of producers largely depends on price-elasticity of supply compared to price. This parameter is not well mastered in Madagascar, but it seems to be very low (Goletti and Rich, 1998; Roubillard, 1998). In this case, the intervention, which effectively redistributes the purchasing power in favor of the poor, does not contribute much to the creation of a global food supply. In this particular strategy, it is question of a redistribution of the consumption of key food crops, not of a notable increase in the global supply of basic commodities.

The advantage of this intervention category is that it theoretically helps to target the most vulnerable households, regions and seasons. The benefits are exclusively concentrated during the lean season (compare Tables 4 and 5). The intervention seems particularly effective in the South due to the high caloric density of food expenditures in the region (Table 4).

Nevertheless, there are numerous inconveniences. First, identification, administration and targeting costs of poorest households are often too prohibitive (Dorosh and Haggblade, 1997; Ravillion, 1991). Therefore the intervention is hard to perpetuate; it is normally unsustainable over the long term, except in countries with important international aid flows. Secondly, this intervention does not increase the total offer of available food, except indirectly and slightly through a small incentive to farmers resulting from the rise of key food crops price of approximately 1%.

2. Seasonal rice imports: increased supply

In contrast, basic food imports constitute an attack in a completely opposite direction. It increases key food supply and relies on a reduction of the latter's price to encourage consumption.

The imports of 100,000 tons of rice[12] made at the beginning of year would induce a reduction of approximately 15% of the rice price during the lean season (Table 4). This leads to an additional 4% caloric intake on average in poor households. The most significant impact will occur in urban areas where caloric increase will be 16%.[13]

The advantage of rice imports is that they target well the lean season – imports can be made at any time. Moreover, for the time being, nearly all private rice imports take place at the beginning of year, from January through April (Table a.1). Among all options, this one is particularly favorable to the urban poor. As a consequence, this intervention might be politically advantageous to calm a highly visible population, having a direct access to political decision-makers.

There are also significant inconveniences. First, rice price reduction also reduces incentives not only to domestic production but also to private imports. According to our calculations, government imports of 100,000 tons of rice will increase domestic consumption by approximately one-half (55,000 tons) since domestic production would decrease by 30,000 tons and private imports will drop by 17,000 tons (Table 5). Moreover, rice – unlike other food crops – influences the price of other basic food commodities. With an annual fall of 10% in the rice price, the prices of secondary food products would fall by 5% to 10% (Table 5). Because of the important share of rice in household caloric intake, falling rice price results in increased consumption and decreasing demand for other caloric sources like maize, cassava and other tubers. Since a small share of the rice market is worth most of the secondary markets, the impact on the other products will be considerable. The subsequent result is a decline in secondary culture production of 30,000 tons on the whole (Table 5). Thus, while urban poor consumers benefit from significant rice imports in the short term, farmers consequently suffer from reduced income, and the country is affected by a significant decline in food production. Increased imports confronted by declining local production also result in foreign exchange outflows. Like transfers, this kind of intervention is punctual and unsustainable. In order to ensure continuity, it is necessary to repeat the spending every year.

[12] We also considered the possibility of importing other key food crops. It would not be possible for tubers since they are perishable and are not traded on a large scale on international markets (except dry cassava which is exported in Europe for animal feed). Maize which is marketed on a large scale has a very narrow place in the domestic market. Consequently, all our simulations with 100,000 tons (an increase of more than 50% of the current production) blew up the model. Importing on this scale will probably disrupt the domestic market of maize. Thus, only rice imports were considered.

[13] This suggests that the majority of governmental imports will be sold in urban areas. Practically, it would be both costly and difficult to sell imports in remote rural areas, especially during the rainy season. Nevertheless, we undertook a sensitivity analysis to observe the impact of the more or less important distribution in rural areas. In the final analysis, we assumed that a quarter of imports will be sold in rural areas (see Simulation 2b in Appendix table a.8).

3. Agricultural productivity: simultaneous increase of supply and income

Increased agricultural productivity will increase both total supplies through an increase in national production, and household income of farmers who will benefit from the increase in the quantity of production. Increases in the productivity of rice, cassava and other tubers are simulated at 6,3%, 13,9% and 20,2% respectively, all the shocks being defined as equivalent to 100 000 tons of rice in value terms.

For the three food crops, increased supply would reduce consumer prices of products, which are subject of the intervention. As a consequence, consumers will buy more of such products to the detriment of other substitutes. But the price reduction rate varies according to the importance of demand elasticity, and is generally lower for rice (Table a.4). For this reason, the annual price of rice falls by approximately 7% vs. 19% and 18% for cassava and tubers (Table 5).

In the case of rice, the direct impact on its own price will be felt also in the prices of other food crops. Because of the importance of rice in overall household consumption, a reduced rice price, which subsequently increases rice consumption significantly reduces the purchase of other major substitutes, the physical capacity of consumption being limited. For this reason cross prices elasticities of rice are often significant and positive; whereas for secondary products, cross prices elasticities are almost zero (see Table a.4 and Ravelosoa et al. 1999). On the other hand, secondary products do not have much influence on other food products.

The increase in production (Simulation 3) leads to a less important reduction of the rice price during the lean season, (- 5%) compared to the reduction resulting from an identical rise of rice imports (Simulation 2, -15%) for two reasons. First, imports targeted the lean season. On the contrary, agricultural productivity will have a major impact when the rice harvest is at its maximum, i.e. in April and May. But even for the annual level, we notice a lesser impact of agricultural productivity since the price of locally produced rice drops by 7% vs. 10% for imports (Table 5). This is explained by the second great difference between the two approaches: agricultural productivity simultaneously influences rice supply and farmers' household income, through the quantity impact, which increases rice producers' income. Imports only increase rice supply without any impact on household income. Increased income of agricultural rural households increases their demand for all food products, which in turn increases their caloric intake and supports food prices. For this reason, poor rural households in rice producing areas (outside the South) get three times higher caloric intake through productivity increase than through imports (1,5% vs. 0,4%; Table 5). Yet, non-agricultural households, especially the urban poor, benefit more from imports, with a caloric rise of 5,2% vs. 2,6% from rice productivity (Table 5). Urban households benefit from a maximum price reduction caused by imports.

Thus, the productivity of various food crops targets various categories of poor households. Rice, as mentioned earlier, targets in particular the urban poor who benefit from a caloric rise of 2% during the lean season, i.e. almost twice more than rural poor with a 1,1% and 1,3% rise (Table 4). On the other hand, cassava particularly supports households in the South whom experience increased caloric intake of 2,5% during the lean season vs. 1,2% and 1,6% for other poor households (Table 4). Tubers other than cassava (sweet potatoes, taro, and potatoes) favor rural households outside the south. These differences come from varied food preferences of the various household groups.

The disadvantage of interventions that exploit agricultural productivity is that they do not target the lean season specifically. Their influence is felt throughout the year, in harvest time in particular. Yet, as food poverty is felt throughout the year, these impacts are rather beneficial to poor households. Therefore, investments in agricultural research, although extremely profitable over the long term (Andersen et al., 1994), require a period of experimentation and adjustment unknown at the start and often of long duration, before bearing fruit.

The advantages of actions that increase agricultural productivity are considerable. First, unlike all other action, they are sustainable. New varieties and the best production techniques are sustainable once popularized. On the other hand, government imports and seasonal income transfers to poor households require a new public expenditure every year; they are punctual and unsustainable over the long term unlike agricultural productivity. Increased agricultural productivity also promotes self-sufficiency and reduces import needs. Transfers and imports increase foreign exchange outflows to support increased food imports, while increasing agricultural productivity will promote foreign exchange savings and, consequently, reinforce the value of the Malagasy franc on the market. Finally, agricultural productivity is the only intervention that affects both the prices of basic food commodities and rural household income.

Table 4 -- Impact of food interventions during the lean season (January and February)

Simulations	**1**	**2**	**3**	**4**	**5**
Shocks	income	Rice imports	Increase in agricultural productivity		
Tool	transfer to poor households		rice	cassava	other tubers
quantity	5.60% of income	100.000 tons	6.3%	13.9%	20.2%
period	January & February	January/February March/April	Throughout the year following with agricultural schedule		
1. Impacts on basic commodities					
a. Price change in January and February (percentage)					
Rice	2.4	-13.4	-5.1	-0.1	0.0
Fresh cassava	2.7	-6.8	-3.0	-18.3	-0.1
Dry cassava	1.2	-2.8	-1.1	-0.1	0.0
Other tubers	2.6	-7.1	-3.0	-0.1	-16.2
Maize	3.9	-7.8	-3.5	-0.2	-0.1
b. Change in consumed quantity in January and February (percentage)					
Rice	1.1	9.1	3.0	-0.1	0.0
Fresh cassava	0.8	-2.0	-0.9	13.2	0.0
Dry cassava	2.0	-4.8	-1.9	-0.1	0.0
Other tubers	0.4	-1.2	-0.5	0.0	13.4
Maize	1.8	-3.8	-1.7	-0.1	0.0
2. Impacts on poor households					
a. Change in caloric intake in January and February (percentage)					
Rural poor, South excluded	2.7	1.9	1.3	1.2	1.6
South rural poor	4.1	2.1	1.1	2.5	0.7
Urban poor	1.5	15.8	2.0	1.6	1.2
Total poor	2.6	4.2	1.4	1.4	1.5
b. Number of new non-poor*** in January and February (thousands of people)					
Rural poor, South excluded	89.2	63.8	45.5	40.1	54.9
South rural poor	18.7	4.2	1.7	7.4	1.1
Urban poor	22.8	144.9	30.1	26.4	27.9
total poor	130.6	212.9	77.3	73.9	83.8

Source: simulations of seasonal model.

* All shocks are defined as equivalent to 100.000 tons of rice in value terms

** In these basic simulations, food crops supply elasticities are equal to 0,2. For a sensitivity analysis with an elasticity of 0,5, see appendix a.6. table

*** For whom caloric intake increase exceeds 2,133 calories per capita per day.

Table 5 – Annual impacts of food interventions

Simulations	1	2	3	4	5
Shocks	Income	Rice imports	Increase in agricultural productivity		
Tool	transfer to poor households		rice	cassava	other tubers
quantity	5.6% of income	100.000 tons	6.3%	13.9%	20.2%
period	January & February	January/February March/April	Throughout the year following agricultural schedule		
1. Impacts on basic commodity prices*					
	Change in annual price (percentage)				
Rice	0.8	-12.7	-6.8	-0.8	-0.4
Fresh cassava	0.8	-6.4	-4.2	-19.2	-0.4
Dry cassava	0.9	-5.0	-2.9	-8.9	-0.2
Other tubers	0.7	-5.8	-4.0	-0.7	-18.4
Maize	1.5	-9.5	-6.3	-1.3	-0.6
2. Impacts on poor household caloric intake					
	Change in annual average (percentage)				
Rural poor, South excluded	0.5	0.4	1.5	0.9	1.3
South rural poor	0.8	2.2	2.2	3.6	0.5
Urban poor	0.1	5.2	2.6	2.2	1.3
Total poor	0.5	1.3	1.8	1.3	1.2
3. Impact on annual supply and consumption of basic commodities**					
	Change compared to basic level ('000 tons)****				
a. rice					
production	1.9	-29.6	77.9	-1.0	-0.4
imports	0.7	83.0	-7.8	-0.2	-0.1
consumption	2.6	55.3	51.8	-1.9	-0.9
b. cassava (fresh + dry)					
production	2.5	-20.1	-13.1	176.8	-1.1
consumption	2.5	-20.9	-14.3	121.7	-1.5
c. other tubers					
production	1.0	-8.6	-5.9	-1.0	111.6
consumption	0.8	-6.3	-4.3	-0.7	81.1
d. maize					
production	0.4	-1.8	-1.0	-0.1	0.0
consumption	0.6	-4.1	-2.7	-0.6	-0.3

Source: simulations of seasonal model.

* All shocks are defined as equivalent to 100,000 tons of rice in value terms

** In these basic simulations, food crops supply elasticities are equal to 0.2. For a sensitivity analysis with an elasticity of 0.5, see appendix a.6. table

*** Consumption = production + imports - losses – stock changes. Losses and stock changes as well as imports of secondary products are excluded in this table due to the low amount and for sake of simplicity.

**** See appendix a.1 table for background data by period.

C. Seasonal implications of inequality

As a result of the unequal distribution of income, land and other economic assets, the majority of Malagasy households permanently stay below the poverty line. This is reflected in Figures 1, 6 and 7, which show that the majority of the Malagasy people permanently eat below essential caloric needs. The depth of extreme poverty in Madagascar is shown schematically by the large gap between the needs and the available funds of the poorest households (Figure 1). This depth limits the number of households in position to cross and pass, even seasonally, the poverty line.

Consequently, seasonal interventions would be more effective if extreme poverty was less important.[14] This is shown by the figures indicated at bottom of table 4. Only 100,000 to 200,000 individuals are prevented from falling below the established standards during the lean season. Those are the most well off among the poor who live close to the limit of required caloric needs.

A small calculation will illustrate the importance of this unequal distribution. Let us assume an income transfer programme to poor households aiming at raising the consumption level for one million poor to enable them to cross the food poverty line all year round, even during the lean season. If such a transfer is targeted at the most well off among the poor, the related costs will be far less important than for the very poor (far left of Figure 1). Based on caloric elasticities of household needs (see Table 4), we calculated the cost of two different transfers, one targeted at the sixth decile of the population (those just below the poverty line), the other targeted at the second decile (the very poor, left of Figure 1). For the first group, the less poor, it is enough to increase caloric intake by 4% on average. For the very poor, on the other hand, it should be increased by over 100%. Consequently, the intervention is more costly. In order to pull one million of well-of poor out of poverty during the lean season, a transfer of approximately 34 billion FMG would be necessary in January and February. On the other hand, to pull one million of the very poor out of poverty, a sevenfold higher transfer of 245 billion FMG would be necessary. Because of inequality, poverty alleviation and the seasonal decrease in the welfare of households become more costly and more difficult.

To ensure an adequate diet during the lean season for the 10 million Malagasy living in difficulty, an extension of these calculations suggests that a well-targeted income transfer of approximately 1,600 billion FMG, i.e. more than 6% of GDP, or half the government tax receipts, would be necessary. Of course, transfers will not solve the issue of seasonal poverty, except on a very small scale when targeting the poorest.

For agricultural productivity, a similar calculation comes to the same conclusion: inequality makes poverty reduction, annual and seasonal, more complicated. An increased productivity similar to that experienced by Asia during the Green Revolution (GR) will be necessary to increase caloric intake to pull one million Malagasy poor people past the poverty line permanently, even during the lean season. If increased productivity targets only rice, a rise of 40% in productivity will be necessary. If new agricultural technologies also target cassava and

[14] See also Khan et al. (1993) on the aggravation of food issues due to inequality.

other tubers, a rise of 22% will be sufficient to pull one million poor people past the poverty line (Figure 8). In theory, such a Green Revolution would be one of the most powerful instruments for poverty alleviation in Madagascar. By definition, poverty results from lack of resources for a household to consume sufficient calories. Consequently, the most effective interventions will be those targeting simultaneously household income and the prices of key food crops. A significant increase in agricultural productivity actually represents such an intervention: it simultaneously exploits the two main aspects of the issue of poverty –household income and the prices of key food crops.

But even the Green Revolution will not solve the issue of inequality in Madagascar. The consequence of the very unequal distribution of land and other productive assets of poor households is that richer households who possess more lands feel the impact on income more acutely. The poorest have very few lands (Dorosh et al., 1997). Consequently, increased income induced by a perceptible increase in productivity will benefit more the average rural population and large farmers. On the other hand, the second great impact of an agricultural revolution, the impact on basic food prices, will benefit all the poor, including urban and non farmer rural poor. As a result, one million poor people will cross the poverty line permanently. But the most well off of the current poor will be those in position to cross this economic border.

For this reason, seasonal poverty reduction efforts will still be confronted with the issue of inequality. Thus, the fight against inequality remains a key element in the long-term fight against seasonal reduction of the welfare of vulnerable households.

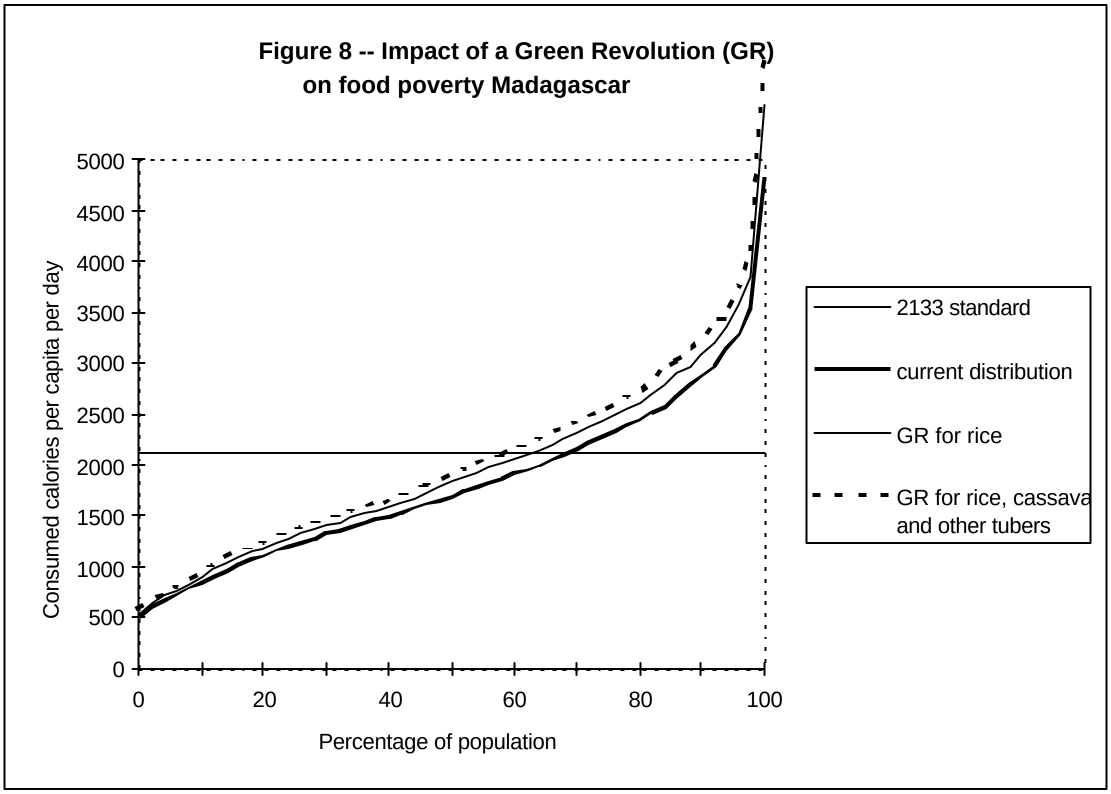


Figure 8 -- Impact of a Green Revolution (GR)
on food poverty Madagascar
Consumed calories per capita per day
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
Percentage of population
2133 standard
current distribution
GR for rice
GR for rice, cassava
and other tubers

5. CONCLUSIONS

Poor Malagasy households are affected by significant seasonal reduction in food consumption. During the lean season, approximately 1 million Malagasy fall below the poverty line to join the 9 millions who live there permanently. The seasonal pressure seems more acute in rural areas where seasonal price fluctuations are three times higher than in urban areas. This considerable reduction affect both adult productivity and child health and mortality. What actions should be taken to face the important human and economic costs involved?

Among the food interventions discussed, seasonal income transfers are too costly to solve the issue of seasonal reduction in food consumption of poor households. It would cost close to 1,600 billion FMG in well-targeted transfers every year (i.e. 50% of government tax receipts) to move all the Malagasy people out of seasonal poverty. Nevertheless, this kind of transfer may bring small-scale relief in the South where it proves to be most effective.

Rice imports, which reduce the rice price, are beneficial to urban households, but much less to rural households. Exploiting only the reduction of the purchase price, such imports are expensive in terms of reduced production incentives and in foreign exchange outflows. The rice price also influences the prices of secondary commodities. Thus, a great quantity of rice imports will reduce domestic production not only of rice but also of cassava, other tubers and maize.

The most promising food interventions appear to be those aiming at increasing agricultural productivity of the main foodstuffs. At the same time, they increase food security in consumer households and the entire country, as increased domestic production leads to a reduction of the quantity of imports. It also saves foreign exchange. If seasonal pressure is felt more acutely in rural areas, the secondary cultures will become priority. Among the basic cultures, cassava and other tubers target especially rural households, who appear to be the most affected by seasonal pressures. Activities aiming at increasing rice productivity are also beneficial, but they mostly favor poor urban households, which are the least affected by seasonal pressures.

In addition to food interventions, there certainly exist complementary activities in public health and education to mitigate the consequences of seasonal food pressure. Since they require completely different data and analysis tools, they are not discussed in this report. Nevertheless, an assessment of such actions would be complementary to this study on food interventions.

Food poverty is deeply rooted in Madagascar due to the highly uneven distribution of income, land and other economic assets. Seasonal improvement is therefore hard to achieve without tackling the basic issue of chronic poverty. For this reason, a Green Revolution alone even on the same scale as in Asia will not eradicate poverty among the very poor, although it would move 1 million Malagasy living just below the poverty line permanently out of poverty. An increased welfare level of the poorest would increase the number of households likely to profit from seasonal interventions. To this end, the fight against inequality will greatly benefit the buffer actions on seasonal vulnerabilities currently affecting the poorest Malagasy households.

REFERENCES

Ahlers, T.; Tuluy, H.A., Stryker, J.D., Crofts, R.A. 1984. "Etude du secteur rizicole." Antananarivo: MPARA.

Anderson, Jock R.; Pardey, Philip G; and Roseboom, J. 1994. "Sustaining Growth in Agriculture: A quantitative Review of Agricultural Research Investments." Agricultural Economics 10(1):107-123.

Azam, Jean-Paul et Bonjean, Catherine. 1995. "La formation du prix du riz: théorie et application au cas d'Antananarivo, Madagascar." Revue économique 46(4):1145-1166.

Barrett, Christopher B. 1997. "Food Marketing Liberalization and Trader Entry: Evidence from Madagascar." World Development 25(5):763-777.

Barrett, Christopher B. 1997. "Liberalization and Food Price Distributions: ARCH-M Evidence from Madagascar." Food Policy 22(5):155-173.

Barrett, Christopher B. 1996. "Urban Bias in Price Risk: The Geofigurey of Food Price Distributions in Low-Income Economies." Journal of Development Studies 32(6):830-849.

Barrett, Christopher B. and Dorosh, Paul A. 1996. "Farmers' Welfare and Changing Food Prices: Nonparametric Evidence from Rice in Madagascar." American Journal of Agricultural Economics 78:656-669.

Berg, Elliot. 1989. "The Liberalization of Rice Marketing in Madagascar." World Development. 17(5):719-728.

CARE. 1997. "Etude du marché de la filière plantes à tubercules." Antananarivo: Projet d'appui au développement des plantes à tubercules (PATAT).

Chambers, Robert; Longhurst, L. et Pacey, A. eds. 1981. Seasonal Dimensions to Rural Poverty. London: Frances Pinter.

Dorosh, Paul et Haggblade, Steven. 1995. "Filling the Gaps: Consolidating Evidence on the Design of alternative Targeted Food Programmes in Bangladesh." The Bangladesh Development Studies 23(3&4):47-80.

Dostie, Benoît; Randriamamonjy, Josée; et Rabenasolo, Lala. 1999. La filière cassava: amortisseur oublié des vulnérables. Antananarivo: INSTAT.

Goletti, Francesco et Rich, Karl. 1998. “Policy Options for Income Growth and Poverty Alleviation in Madagascar.” Washington, DC: IFPRI.

Herdt, R.W. et Capule, C. 1983. Adoption, Spread and Production Impact of Modern Rice Varieties in Asia. Los Banos, Philippines : International Rice Research Institute.

International Food Policy Research Institute et le Centre National de Recherche Appliquée au Développement Rural (IFPRI/FOFIFA). 1998. "Analysis of Policy Options for Income Growth and Poverty Alleviation." Structure and Conduct of Major Agricultural Inpout and Output Markets and Response to Reforms by Rural Households in Madagascar, Final Report, Part 5. Washington, DC et Antananarivo: IFPRI et FOFIFA.

Institut National de la Statistique (INSTAT). 1995. Enquête Permanente Auprès des Ménages. Antananarivo: INSTAT.

Khan, M. Mahmud; Mock, Nancy B.; Jeannoda, Victor; and Baker, Shawn K. 1993. "Is Madagascar Becoming Increasingly Vulnerable to Food Crises?" Ecology of Food and Nutrition. 29:181-198.

Lapenu, Cécile; Zeller, Manfred; et Ralison, Eliane. 1998. "La consommation en calories et protéines et l'état nutritionnel des ménages ruraux malgaches." Cahier de la Recherche sur les Politiques Alimentaires No. 15. Antananarivo: International Food Policy Research Institute et FOFIFA, Central National de la Recherche Appliquée au Développement Rural.

Mellor, John W. et Johnston, Bruce F. 1984. "The World Food Equation : Interrelations Among Development, Employment and Food Consumption." Journal of Economic Literature (22) :524-531.

Ministère de la Production Agricole et de la Recherche Agronomique (MPARA). 1985. Impact de la stratégie d'autosuffisance en riz. Antananarivo: MPARA and Associates in Rural Development.

Minten, Bart. 1998. "Vivre avec des prix alimentaires variables: une analyse du marché des produits agricoles à Antananarivo." Economie de Madagascar. 2:129-151.

Minten, Bart; Randrianarisoa, Claude et Zeller, Manfred. 1998. “Les déterminants de dépenses de consommation alimentaires et non alimentaires des ménages ruraux.” Cahier de la Recherche sur les Politiques Alimentaires No.14. Antananarivo: IFPRI et FOFIFA.

Minten, Bart; Randrianarisoa, Claude; Zeller, Manfred et Badiane, Ousmane. 1997. “L'accessibilité aux marchés et les prix agricoles." Cahier de la Recherche sur les Politiques Alimentaires No.5. Antananarivo: IFPRI et FOFIFA.

Pinstrup-Andersen, Per; Pandya-Lorch, Rajul; et Rosegrant, Mark. 1999. World Food Prospects: Critical Issues for the Early Twenty-First Century. Washington, DC: International Food Policy Research Institute.

Programme National de Surveillance Alimentaire et Nutritionnel (PNSAN). 1997. «Nutrition et sécurité alimentaire des enfants et des femmes à Madagascar » Antananarivo: PNSAN.

Ravelosoa, Julia Rachel; Haggblade, Steven; et Rajemison, Harivelo. 1999. Estimation des élasticités de la demande à Madagascar à partir d'un modèle AIDS." Antananarivo: INSTAT.

Ravallion, Martin. 1991. "Reaching the Rural Poor through Public Employment: Arguments, Evidence and Lessons from South Asia." The World Bank Research Obserever 6(2):153-175.

Roubaud, Francois. 1997. "La question rizicole à Madagascar: les résultats d'une décennie de libéralisation." Economie de Madagascar 2:37-61.

Roubillard, Anne Sophie. 1998. "L'offre de riz des ménages agricoles malgaches: étude économétrique à partir d'enquêtes transversales." Antananarivo: Version provisoire.

SECALINE. 1997. La situation alimentaire et nutritionnelle à Madagascar: stratégie nationale de sécurité alimentaire et de nutrition. Antananarivo.

SECALINE. 1996. Evaluation de la situation alimentaire et nutritionnelle à Madagascar. Antananarivo: SECALINE.

Timmer, C. Peter. 1997. "Building Efficiency in Agricultural Marketing : The Long-Run Role of BULOG in the Indonesian Food Economy" Journal of International Development 9(1) :133-145.

Waltisperger, Dominique; Cantrelle, Pierre; et Ralijaona, Osée. 1998. La mortalité à Antananarivo de 1984 à 1995. Document et Manuel du CEPED No. 7. Paris: Centre français sur la population et le développement.

World Health Organization (WHO). 1999. A Critical Link: Interventions for Physical Growth and Psychological Development. Geneva: WHO.

APPENDIX A.

SEASONAL MODEL

APPENDIX A. SEASONAL MODEL

1. Objectives

The development of a seasonal model for Madagascar has two major objectives: a) to quantify the seasonality of food consumption and caloric intake among poor households; and b) to assess the efficiency of potential interventions to alleviate food poverty during the lean season.

2. Model Structure

Six seasons. To reflect seasonal price and consumption fluctuations of vulnerable households, the model divides the year into six periods of two months each. The basic seasonal data representing the year 1995 are presented in Table a.1.

Six household groups. - The model also identifies six household groups: the poor and the non-poor in each of the three regions. This identification reflects the differences in income level, consumption structure, behavior and food preferences of the households. These differences are summarized in Table a.2.

Consumption structure and caloric intake level vary according to seasons and household groups. Table a.3. summarizes the seasonal changes of caloric intake level among various household groups.

Seven products. The model identifies five major commodities (rice, fresh and dry cassava, maize, other tubers), other commodities, and a nonfood composite item which makes a total of seven items. Basic commodities need to be detailed to reflect rice substitution by its main energy substitutes. Background data are summarized in Table a.1.

3. Behavior

a. consumption

The consumption of each of the seven items is made up of three elements: human consumption, animal consumption (particularly important for cassava) and consumption of the rest of the world (i.e. exports). The last two consumptions are fixed in the model, and are assumed to be function of the animal population and international markets, which are both exogenous to the model.

On the other hand, household consumption (HC) varies according to income and prices in the following way:

(1) $HC_{hi} = HC0_{hi} * \Pi_j (P_j/P0_j)\text{^}ED_{ijh} * (Y_h/Y0_h)\text{^}EY_{hi}$

where HC_{hi} represents household h consumption of item i, P is item price, Y_h is household annual income (i.e. income during the last six periods), 0 indicate the basic level of each variable, and indices represent household group (h) and item (i). ED_{ijh} parameter represents demand-price elasticities and EY_{hi} represents demand-income elasticities. The symbol Π_j is the multiplication of response price for the seven consumer goods.

This simple formulation of the consumption function considers demand elasticities as constant. Elasticities themselves are derived from a recent estimate by an AIDS model using Permanent Household Survey (PHS) data of 1993/94 (see Ravelosoa et al. 1999). Elasticities estimates are presented in Table a.4.

Income of each household group is composed of three elements: agricultural income (YAG), nonagricultural income (YNONAG) and transfers (YTFRTS).

(2) $Y_h = YAG_h + YNONAG_h * PINDEX + YTFRTS_h$

Transfers are fix and become one intervention tool afterwards. Nonagricultural income is fix in real terms, and agricultural income vary according to farm prices through the following relations:

(3) $YAG_h = \Sigma_i\, p_i * X_i * VA_i * AGSHARE_{ih}$

where X_i is production of item i, VA_i is value added share in total production, and $AGSHARE_i$ is households h share in total production of item i. With this formulation, agricultural income fluctuates depending on the total production and price of one item.

b. <u>supply</u>

The total supply for each item is a function of the domestic production (X_i), imports (M_i) and stock sale ($HPRSTK_i$). Each of the three elements is a function of item price through the following relations.

(4) $X_i = AT_i * {}_{X0i} * \Pi_J (P_j/P0_j)$^$ES_{ij}$

(5) $M_i = M0_i * (1 + EM_i) * (P_i/P0_i) -1)$

(6) $HPRSTK_i = ENDSTK0_i * (P_i/P0_i)$^$BSTK_i - ENDSTKL_i$

where AT_i is a technological parameter, ES_{ij} is offer-price elasticity, EM_i is import-price elasticity, and $BSTK_i$ is offer-price elasticity of stock sale. Parameter values are summarized in Table a.5.

4. Balances

Balances are fixed in a traditional way, requiring that supply be equal to demand:

(7) $X_i * (1\text{-}LOSS_i) + M_i + GOVIMP_i =$

$HC_i + ONANIM_i + EXPORT_i + HPRSTK_i$

where $LOSS_i$ represents seed loss rate for each food crop, $GOVIMP_i$ government imports, $ONANIM_i$ animal consumption, $EXPORT_i$ exports and $HPRSTK_i$ private stock sales.

In order to achieve market balance, the prices vary for the six commodities and imports fluctuate for the non-food item, whose price is standardized to 1.

5. Seasonality

Markets are adjusting for each period. Periods are connected through income, household consumption and availability of private stocks in the next period. Household annual income (Y_h) is a function of income (i.e. of prices and agricultural production) during the former five periods plus the current period. Thus, a price change in TP1 will influence household income and consumption during the next five periods. Stock sales also influence price during the next period, since the stocks available for the end of the period (which are a function of the current price) influence the stock level for the beginning of the next period.

6. Shocks and their impacts

a. exogenous variables (tools to be handled)

Three main shocks are modeled: (1) agricultural productivity, (2) governmental imports, and (3) seasonal transfers to poor households. To model an increasing agricultural productivity (or a negative shock such as cyclone, drought or locust invasion), we just need to change AT_i variable. To increase government imports, $GOVIMP_i$ variable should be handled. Income transfers are handled through $YTFRTS_h$ variable. Imports and transfers may target any period of the year. Normally, it is recommended to operate during the lean season for well-targeted interventions. With agricultural technology, its impact will occur during harvest time, which limits seasonal targeting, except through food crop choice.

b. endogenous variables (impacts)

After any type of intervention, the model resolution quantifies the consequences on endogenous variables. The most important of the endogenous variables include: domestic production level, agricultural income, imports, stock sale, item prices, total income of each household group, item consumption and caloric intake of poor households. All these variables are traced for the six periods of the year.

7. GAMS Codes

The modeling uses GAMS (General Algebraic Modeling System) software. A complete list of codes is available with the authors. For reference and to complete documentation on the model, a reproduction of GAMS codes that summarizes the model equations is presented below.

```
$TITLE MADAGASCAR MULTI-MKT MODEL        MMMKT79.GMS              2/11/99
$OFFSYMLIST OFFSYMXREF



 SET I      commodities    /RIZ               1 riz
                            MAIS              2 maïs
                            MANVERT           3 cassava vert
                            MANSEC            4 cassava sec
                            AUTTUB            5 autres tubercules
                            AUTALIM           6 autres aliments
                            NONALIM           7 non aliments/

     IA(I)             / RIZ, MAIS, MANVERT, MANSEC, AUTTUB, AUTALIM /

     IT(I)  tradeable foods     /RIZ, MAIS, MANSEC, AUTALIM  /


     H       households             /   UPAUVRDP urbain pauvre reste du pays
                                        UNONRDP  urbain non pauvre reste du pays
                                        RPAUVRDP rural pauvre reste du pays
                                        RNONRDP  rural non pauvre reste du pays
                                        PAUVSUD  pauvre dans le Sud
                                        NONSUD   non pauvre dans le Sud/

     RDPH(H) menages du reste du pays / UPAUVRDP, UNONRDP, RPAUVRDP, RNONRDP /
     SUDH(H) menages du sud           / PAUVSUD, NONSUD /
     UH(H)   menages urbains          / UPAUVRDP, UNONRDP/
     RH(H)   menages ruraux           / RPAUVRDP, RNONRDP,PAUVSUD, NONSUD/

       TP       time periods
              /  T1,  T2,  T3,  T4,  T5,  T6  /

     T(TP)   simulations

ALIAS (I,J) ;
ALIAS (IA,IJ) ;

  ;

PARAMETER
A(I,H)        Consumption function intercept
AT(I)         Technology shift parameter for prodn function
AGSHARE(I,H)  Share of agr income per household                          (unity)
C0(I)         Total consumption                                      ('000 tons)
CALKG(I,H)    Calories per gram of commodity i                  (Kcals per gram)
CAL(H,I)      Calories from commodity I                                   (cals)
CAL0(H,I)     Initial calories for commodity I                            (cals)
CALAVG0(I)    Average national calories per person per day                (cals)
CALPART0(H,I) Part de chacque produit dans la consommation calorique du ménage (%)
CHECKA(I,H)   Check consumption function intercept
CONHCAP0(H,I) Consumption per capita by household h                         (kg)
CHKCON1(I)    Check consumption per capita
CHKCON2(I)    Check household consumption data
CHKEQUI(I)    Check for equilibre S=D
CHKPROD(I)    Check for production data
CHPRSTK0(I)   Change in private stocks
CONANIM0(I)   Consommation initiale des animaux                   ('000 tonnes)
D0(I)         Demande totale de bien I                               ('000 tons)
*ED1(I,J)     Elasticite de demande pour la premiere groupe de ménages
```

```
ED(I,J,H)       Price elasticity of demand for household h              (Unity)
EM(I)           Export elasticity of ROW
ENGELCHK(H)     Check de la loi d'Engel                                 (Unity)
EXPORT0(I)      Exports
EY(H,I)         Income elast of demand for household h                  (Unity)
GOVIMP0(I)      Government imports
HC0(H,I)        Consommation initiale du bien i par ménage          ('000 tons)
HCVALSHR(H,I) Part du bien i dans la valeur de la consommation du menage
HH(H)           Number of households                                 (millions)
HCSHAREI(H,I) Part du bien i dan la consommation du ménage
HCVALTOT(H)     Valeur totale de la consommation des ménages              (Fmg)
HOMOGCHK(I,H) Check de l'homogeneite de la fonction de consommation
HCVAL(H,I)      Valeur de la consommation du bien i
IVTGOV0(I)      Investment and government final demand
LNA(I,H)        Log de l'intercepte de la fonction de consommation      (Unity)
LOSS(I)         Losses factor                                           (Unity)
M0(I)           Imports                                             ('000 tons)
MARG0(I)        Domestic marketing margin                               (Unity)
PARTX_H(H,I)    Part de chaque ménage dans la production du bien i          (%)
PARTXCHK(I)     Check la somme des parts
PARTC_H(H,I)    Part de chaque ménage dans la consommation du bien i        (%)
PARTCCHK(I)     Check la somme des parts
PCWT(i)         Weights for consumer price index                        (unity)
PC0(I)          Consumer (urban) price                             (Fmg per kg)
PERTE0(I)       Pertes et semences par produit                      ('000 tons)
PINDEX0         Initial indice des prix (doit etre egale a un)
POP(H)          Population of household group h                      (Milliers)
PP0(I)          Producer (rural) price                             (Fmg per kg)
PPSUP(I)        Producer price for supply function                 (Fmg per kg)
PPSUP0(I)       Producer price for supply function - base          (Fmg per kg)
PRODH(H,I)      Production total par produit et par ménage          ('000 tons)
S0(I)           Offre totale de bien i                              ('000 tons)
SIZE(H)         People per household                                     (each)
SUMCONS(I)      Somme de la consommation par groupes de ménages
SUMPROD(I)      Somme de la production par groupes de ménages
STK0(I)         Private stocks                                      ('000 tons)
TOTCONS         Total value of consumption                      (milliard Fmg)
TOTCAL0(H)      Total initial calories per household group               (cals)
TOTCAL(H)       Total calories per household group                       (cals)
TOTEXP(H)       Total household expenditure                             (unity)
VA(I,H)         Value added coef by activity by household               (Unity)
WT(H,I)         Consumer price index weight                             (unity)
X0(I)           Production                                          ('000 tons)
YH0(H)          Household income                                (milliard Fmg)
YHAG0(H)        Household agriculture income                    (milliard Fmg)
YHAG2(H)        Test de la valeur ajoutée agricole
YHAG3(H)        Test de la valeur ajoutée agricole
YHAGCAP0(H)     Household per capita agricultural income              ('000 Fmg)
YHNAG0(H)       Household non-agricultural income                 (million Fmg)
YHCAP(H)        Annual per capita household income                   ('000 Fmg)
YHCAP0(H)
BSTK(I)         Price responsiveness of stock parameter                 (Unity)
ENDSTOCK0(I)    End of stock in current period base                 ('000 tons)
ENDSTOCKL(I)    End of stock in previous period                     ('000 tons)
;


[ENTREE DES DONNEES BRUTES: PAS REPRODUITES]


* Définition du modèle
VARIABLES
* Price block
   PC(I)          Consumer (urban) price                           (Fmg per kg)
   PP(I)          Producer (rural) price                           (Fmg per kg)
   PINDEX         Consumer price index                                  (unity)
   MARG(I)        Domestic marketing margin                             (Unity)
* Commodity flows
```

```
   X(I)           Production                                  ('000 tons)
   C(I)           Total consumption                           ('000 tons)
   HC(H,I)        Household consumption                       ('000 tons)
   CONANIM(I)    Consommation animale                        ('000 tons)
   M(I)           Importations privées                        ('000 tons)
   GOVIMP(I)      Government imports                          ('000 tons)
   EXPORT(I)      Exportations                                ('000 tons)
   IVTGOV(I)      Investment and government spending             (Bn Fmg)
   CHPRSTK(I)     Change in private stocks                    ('000 tons)
   ENDSTOCK(I)    End of period private stocks                ('000 tons)
* Incomes, etc.
   Y              National income                                (Bn Fmg)
   YH(H)          Household income                               (Bn Fmg)
   YHAG(H)        Household agricultural income                  (Bn Fmg)
   YHNAG(H)       Household non-agricultural income              (Bn Fmg)
   YHAVE(H)       Household average income                       (Bn Fmg)
   TRANSFER(H)    Transfer income to household h
* Objective function
   OMEGA          Objective function                             (Bn Fmg)
```

```
EQUATIONS
* Price block
   PPDEF(I)        Defin of producer price                            (Fmg per kg)
   PINDXDEF        Defin of consumer price index                           (unity)
* Commodity flows
   XDEF(I)         Production equation                                ('000 tons)
   CONDEF(I)       Consumption equation                               ('000 tons)
   UHCONDEF(H,I)   Urban household consumption eqn                    ('000 tons)
   RHCONDEF(H,I)   Rural household consumption eqn                    ('000 tons)
   TRADE(I)        Trade equation                                     ('000 tons)
   CHSTKEQ(I)      Change in stock equation                           ('000 tons)
   ENDSTKEQ(I)     End stock equation                                 ('000 tons)
   EQUIL(I)        Equilibrium equation                               ('000 tons)
* Incomes,etc.
   YDEF            Income equation                                       (Bn Fmg)
   YHDEF(H)        Household income equation                             (Bn Fmg)
   YHAGDEF(H)      Ag income equation                                    (Bn Fmg)
   YHAVEDEF(H)     Average household income equation                     (Bn Fmg)
* Objective function
   OBJ             Objective function
   ;



* Model definition - price block
PPDEF(I)..         PP(I) =E= PC(I) / (1 + MARG(I)) ;

PINDXDEF..    PINDEX =E= SUM(I,PCWT(I)*PC(I)/PC0(I) ) ;

* production and consumption
XDEF(I)..          X(I) =E=   AT(I) * X0(I) * PROD(J,
                    (PP(J)/PP0(J))**ES(I,J) ) ;

CONDEF(I)..        C(I) =E= SUM(H, HC(H,I)) ;

UHCONDEF(UH,I).. HC(UH,I) =E= HC0(UH,I)
                * PROD(J,(PC(J)/PC0(J))**ED(I,J,UH)  )
                * (YHAVE(UH)/YHAVE0(UH))**EY(UH,I) ;

RHCONDEF(RH,I)..      HC(RH,I) =E= HC0(RH,I)
                * PROD(J,(PP(J)/PP0(J))**ED(I,J,RH)  )
                * (YHAVE(RH)/YHAVE0(RH))**EY(RH,I) ;

TRADE(IT)..  M(IT) =E= M0(IT) * (1+EM(IT)*(PC(IT)/PC0(IT)-1)) ;

YHDEF(H)..    YH(H) =E= YHAG(H) + YHNAG(H)*PINDEX  ;

YHAGDEF(H)..       YHAG(H) =E= SUM(I, AGSHARE(I,H)*PP(I)*X(I)*VA(I,H)/1000 );

YHAVEDEF(H)..      YHAVE(H) =E= YH(H) + YHL(H) + TRANSFER(H) ;

* Market clearing
ENDSTKEQ(I)..  ENDSTOCK(I) =E= ENDSTOCK0(I) * (PC(I)/PC0(I)) **BSTK(I);

CHSTKEQ(I)..       CHPRSTK(I) =E= ENDSTOCK(I) - ENDSTOCKL(I) ;

EQUIL(I)..         X(I)*(1-LOSS(I)) + M(I) + GOVIMP(I) =E=
                    C(I) + CONANIM(I) + EXPORT(I) + IVTGOV(I) + CHPRSTK(I) ;

OBJ..              OMEGA =E= 10 ;
```

```
* closure: set fixed variables
CONANIM.FX(I) = CONANIM0(I) ;
EXPORT.FX(I) = EXPORT0(I) ;
GOVIMP.FX(I) = 0 ;
IVTGOV.FX(I) = 0 ;
M.FX("MANVERT") = M0("MANVERT") ;
M.FX("AUTTUB") = M0("AUTTUB") ;
MARG.FX(I) = MARG0(I) ;
PC.FX("NONALIM") = PC0("NONALIM") ;
TRANSFER.FX(H) = 0 ;
YHNAG.FX(H) = YHNAG0(H) ;



* choc qui lance la simulation
* AT("RIZ") = AT("RIZ")*1.063 ;
* AT("MANVERT") = AT("MANVERT") * 1.139 ;
* AT("MANSEC") = AT("MANSEC") * 1.139 ;
* AT("AUTTUB") = AT("AUTTUB") * 1.202 ;
* GOVIMP.FX("RIZ") = 100 ;
*TRANSFER.FX("PAUVSUD") = YHAVE0("PAUVSUD")*0.056 ;
*TRANSFER.FX("UPAUVRDP") = YHAVE0("UPAUVRDP")*0.056 ;
*TRANSFER.FX("RPAUVRDP") = YHAVE0("RPAUVRDP")*0.056 ;



OPTIONS ITERLIM=200, LIMROW=1, LIMCOL=1 ;
OPTIONS SOLPRINT=OFF ;


MODEL MADMM1  /
  XDEF,
  YHAGDEF, YHDEF, YHAVEDEF,
  PPDEF, PINDXDEF,
  UHCONDEF, RHCONDEF, CONDEF,
  TRADE,
  ENDSTKEQ, CHSTKEQ,
  EQUIL, OBJ / ;


SOLVE MADMM1 MiniMIZING OMEGA USING NLP;
```

Table A.1 – Seasonal baseline data of key food crops, 1995

Product	TP1 January Februar	TP2 March April	TP3 May June	TP4 July Aug	TP5 September October	TP6 November December	Annua Total
Rice	*price (MGF/kilo)*						*average*
Urban price	1,845	1,793	1,602	1,637	1,741	1,811	1,738
Rural price	1,712	1,581	1,103	1,190	1,451	1,625	1,444
	quantity('000 tons)						*total*
Production	236	796	236	0	325	0	1593
Imports	18	98	0	1	8	1	125
Sales of private stocks	8	-516	80	260	-35	222	19
Exports	0	0	0	0	0	0	1
Losses and seeds	45	152	45	0	62	0	304
Animal consumption	0	0	0	0	0	0	0
Human consumption	217	225	271	261	235	222	1432
Fresh assava	*price (MGF/kilo)*						*average*
Urban price	581	570	553	564	564	564	566
Rural price	512	484	442	470	470	470	475
	quantity ('000 tons)						*total*
Production	231	231	231	231	231	231	1386
Imports	0	0	0	0	0	0	1
Sales of private stocks	4	3	-11	-11	0	7	-8
Exports	0	0	0	0	0	0	0
Losses and seeds	52	52	52	52	52	52	314
Animal consumption	55	55	55	55	55	55	330
Human consumption	128	127	112	113	124	131	734
Dry cassava	*price (MGF/kilo)*						*average*
Urban price	945	945	983	945	870	917	934
Rural price	803	803	897	803	616	733	776
	quantity ('000 tons)						*total*
Production	0	0	0	259	259	0	518
Imports	0	0	0	0	0	0	0
Sales of private stocks	85	90	73	-182	-152	88	3
Exports	0	7	0	0	15	0	22
Losses and seeds	0	0	0	0	0	0	0
Animal consumption	32	32	32	32	32	32	194
Human consumption	53	51	40	45	59	55	304
Other tubers	*price (MGF/kilo)*						*average*
Urban price	1,129	1,093	1,152	1,271	1,259	1,236	1,190
Rural price	841	752	901	1,198	1,168	1,109	995
	quantity ('000 tons)						*total*
Production	121	121	121	121	121	121	725
Imports	0	0	0	0	0	0	0
Sales of private stocks	17	21	-6	-17	-9	-2	5
Exports	0	0	0	0	0	0	0
Losses and seeds	33	33	33	33	33	33	198
Animal consumption	0	0	0	0	0	0	0
Human consumption	105	109	82	71	79	86	532
Maize	*price (MGF/kilo)*						*average*
Urban price	1,364	1,326	1,261	1,248	1,236	1,300	1,289
Rural price	1,266	1,169	1,008	976	944	1,105	1,078
	quantity ('000 tons)						*total*
Production	28	28	129	0	0	0	186
Imports	0	0	0	0	0	0	0
Sales of private stocks	3	3	-103	32	32	31	-1
Exports	1	1	0	4	1	0	7
Losses and seeds	0	0	0	0	0	0	0
Animal consumption	0	0	0	0	0	0	3
Human consumption	30	30	26	27	31	31	175

Table A.1 -- continued

Product	TP1 January Februar	TP2 March April	TP3 May June	TP4 July Aug	TP5 September October	TP6 November December	Annual total
Other food crops							*average*
Urban price	1	1	1	1	1	1	1
Rural price	1	1	1	1	1	1	1
	quantity ('000 tons)						*total*
Production	294	294	294	294	294	294	1761
Imports	38	38	38	38	38	38	230
Sales of private stocks	-8	-4	13	10	0	-5	6
Exports	166	166	166	166	166	166	996
Losses and seeds	0	0	0	0	0	0	1
Animal consumption	0	0	0	0	0	0	0
Human consumption	158	162	179	175	166	160	1000

Source: INSTAT, Prices Department and Foreign Trade Department; Minagri.

Table A.2 – Households characteristics

	Households					
	Rural South		Rural, rest of country		Urban	
	poor	non poor	poor	non poor	poor	non poor
Population (millions)	756	306	6,308	2,323	1,368	1,273
Income per capita ('000 FMG per annum)	378	666	462	934	1,292	4,391
Consumption (kg per capita per annum)						
rice	42	59	107	154	123	129
fresh cassava	54	101	68	77	36	13
dry cassava	31	48	5	3	7	3
other tubers	28	55	53	41	26	17
maize	45	60	12	13	8	6
other products	84	136	50	100	77	188
non food	267	435	312	600	1,050	3,827

Source: INSTAT, MaCS 1995; Minagri.
* Non food consumption in '000 FMG per capita per annum)

Table A.3 – Seasonality of caloric intake

Household group	TP1 January February	TP2 March April	TP3 May June	TP4 July Aug	TP5 September October	TP6 November December	Annual average
Rural South							
poor	1,790	1,836	1,979	1,943	1,974	1,861	1,869
non-poor	2,810	2,866	2,975	2,935	3,039	2,902	2,888
Rural rest of country							
poor	1,873	1,931	2,103	2,019	1,921	1,869	1,920
non-poor	2,540	2,606	2,804	2,720	2,618	2,558	2,611
Urban							
poor	1,932	1,958	2,033	2,007	1,970	1,941	1,963
non-poor	2,252	2,274	2,343	2,324	2,289	2,262	2,279

Source: Basic simulations of seasonal model.

Table A.4 – Consumption elasticities

	Households					
	Rural South		Rural, rest of country		Urban	
	poor	non-poor	poor	non-poor	poor	non-poor
Income elasticities						
rice	0.78	0.78	0.75	0.41	0.48	0.07
cassava	0.75	0.75	0.28	0.5	-0.08	-1.92
other tubers	1.13	1.13	0.2	-0.24	0.07	0.25
maize	0.5	0.5	0.53	-0.05	0.27	-0.44
other products	1.77	1.77	1.25	1.37	1.12	0.95
non-food	1.21	1.21	1.5	1.39	1.35	1.26
Proper price elasticities						
rice	-1.52	-1.52	-0.62	-0.48	-0.53	-0.45
cassava	-1.05	-1.05	-0.42	-0.76	-1.01	-1.13
other tubers	-0.49	-0.49	-0.68	-0.63	-1.25	-1.16
maize	-0.66	-0.66	-0.3	-0.29	-0.55	-0.61
other products	-0.64	-0.64	-0.76	-0.81	-0.62	-0.25
non food	-1.12	-1.12	-0.74	-0.9	-0.93	-1.13
Elasticities compared to rice price						
rice	-1.52	-1.52	-0.62	-0.48	-0.53	-0.45
cassava	0.5	0.2	0.5	0.2	0.6	0.2
other tubers	0.5	0.2	0.5	0.2	0.6	0.2
maize	0.8	0.8	0.5	0.2	0.6	0.2
other products	-0.6	-0.2	-0.6	-0.2	-0.6	-0.2
non-food						

Source: Ravelosoa, Haggblade and Rajemison (1999).

Table A.5 – Supply-price elasticities

	Supply elasticity		
	production	imports	stock change**
Model variable	ES*	EM	BSTK
Supply elasticity			
rice	0.2	1	-0.5
dry cassava	0.2	0	0
fresh casssava	0.2	0	-0.5
other tubers	0.2	0	0
maize	0.2	1	-0.5
other products	0.2	1	-0.5
non food products	0.2	n.a.	-0.5

Source: Seasonal model and Goletti & Rich (1998).

* A sensitivity analysis was completed with a supply elasticity of 0,5 for all products. Analytical results are presented in Tables a.6 and a.7.

** Stock decline is equivalent to sales increase.

Table A.6 -- Impact of food interventions during the lean season (January and February) sensitivity analysis with food crops supply elasticities of 0,5**

Simulations	1	2	3	4	5
Shocks	Income	Rice imports	Increased agricultural productivity		
Tool	transfer to poor households		rice	cassava	other tubers
quantity	5.60% of income	100.000 tons	6.3%	13.9%	20.2%
period	January & February	Jan/Feb Mar/Apr	Throughout the year, in conformity with agricultural schedule		
1. Impacts on basic food commodities					
a. Price change in January and February (percentage)					
rice	1.9	-16.5	-4.1	-0.1	0.0
fresh cassava	1.7	-7.1	-1.6	-12.9	0.0
dry cassava	1.1	-3.8	-0.9	0.0	0.0
other tubers	1.8	-8.0	-1.9	-0.1	-12.8
maize	2.7	-9.0	-2.1	-0.1	0.0
b. Change in quantities consumed in January and February (percentage)					
rice	1.4	10.1	2.4	0.0	0.0
fresh cassava	1.2	-5.0	-1.1	8.8	0.0
dry cassava	1.8	-6.4	-1.5	-0.1	0.0
other tubers	0.7	-3.4	-0.8	0.0	10.2
maiz	2.0	-7.0	-1.6	-0.1	0.0
2. Impacts on poor households					
a. Change in caloric intake in January and February (percentage)					
rural poor, except South	3.0	3.8	1.0	0.8	1.2
South rural poor	4.5	3.1	0.7	1.7	0.5
urban poor	1.8	6.9	1.5	1.1	0.9
total poor	2.9	4.3	1.0	0.9	1.1

Source: simulations of seasonal model.

* All shocks are defined as equivalent to 100,000 tons of rice in value terms

Table A.7 -- Impact of rice imports during the lean season, sensitivity analysis

Simulations	2a	2b	2c	2d	2e
Shocks					
tool			Rice imports		
quantity			100.000 tons		
period			Jan/Feb Mar/Apr		
Rural price adjustment to urban price	0	0.25	.5	0.75	1
1. Impacts on basic food commodities**					
a. Price change in January and February (percentage)					
rice	-8.1	-13.4	-16.6	-18.6	-19.8
fresh cassava	-2.7	-6.8	-9.4	-11.1	-12.3
dry cassava	-1.5	-2.8	-3.7	-4.2	-4.6
other tubers	-3.2	-7.1	-9.6	-11.2	-12.3
maize	-3.2	-7.8	-10.8	-12.6	-13.9
b. Change in quantity consumed in January and February (percentage)					
rice	7.0	9.1	10.7	11.8	12.7
fresh cassava	-0.8	-2.0	-2.8	-3.3	-3.6
dry cassava	-2.5	-4.8	-6.2	-7.2	-7.8
other tubers	-0.5	-1.2	-1.7	-2.0	-2.2
maize	-1.5	-3.8	-5.3	-6.3	-7.0
2. Impacts on poor households					
a. Change in caloric intake in January and February (percentage)					
Rural poor, except South	-0.2	1.9	3.4	4.5	5.3
South rural poor	0.6	2.1	3.4	4.4	5.1
Urban poor	20.5	15.8	12.6	10.4	9.0
total poor	3.3	4.2	4.9	5.5	5.9

Source: simulations of seasonal model

* All shocks are defined as equivalent to 100,000 tons of rice in value terms

** In these basic simulations, food crops supply elasticities are equal to 0,2. For a sensitivity analysis with an elasticity of 0,5, see appendix a.6. table

*** For whom caloric intake increase exceeds 2.133 calories per capita per day.

Table A.8 – Annual impacts of food interventions,
Sensitivity analysis with food crops elasticities of 0,5

Simulations	**1**	**2**	**3**	**4**	**5**
Shocks	Income	Rice imports	Increased agricultural productivity		
Tool	transfer to poor households		rice	cassava	other tubers
quantity	5.6% of income	100.000 tons	6.3%	13.9%	20.2%
period	January & February	Jan/Feb Mar/Apr	Throughout the year, in conformity with agricultural schedul		
1. Impacts on basic commodities price					
	Change in annual average price (percentage)				
rice	0.6	-7.6	-5.1	-0.5	-0.2
fresh cassava	0.5	-3.9	-2.1	-13.4	-0.2
dry cassava	0.8	-4.4	-2.1	-6.4	-0.1
other tubers	0.5	-3.8	-2.3	-0.3	-14.2
maize	1.0	-7.1	-4.2	-0.8	-0.4
2. Impacts on poor household caloric intake					
	Change in annual average (percentage)				
Rural poor, except South	0.6	-0.2	1.1	0.5	1.0
South rural poor	0.9	1.1	1.5	2.3	0.4
Urban poor	0.2	2.8	1.8	1.4	0.9
total poor	0.6	0.4	1.2	0.8	0.9
Non poor households	-0.1	0.8	1.0	1.4	0.5
3. Impact on annual supply and consumption of basic food commodities*					
	Change compared to basic level ('000 tons)****				
a. rice					
production	3.5	-61.3	58.3	-1.3	-0.7
imports	0.5	89.7	-6.0	-0.1	0.0
consumption	3.6	37.3	38.7	-1.8	-0.9
b. cassava (fresh and dry)					
production	3.5	-29.9	-16.5	117.7	-1.4
imports	0.0	0.0	0.0	0.0	0.0
consumption	3.1	-27.0	-15.6	80.7	-1.5
c. other tubers					
production	1.6	-14.1	-8.3	-1.2	82.3
imports	0.0	0.0	0.0	0.0	0.0
consumption	1.2	-10.2	-6.0	-0.8	59.8
d. maize					
production	0.6	-3.1	-1.3	-0.1	0.0
imports	0.0	0.0	0.0	0.0	0.0
consumption	0.7	-4.8	-2.5	-0.4	-0.2

Source: simulations of seasonal model.
* All shocks are defined as equivalent to 100,000 tons of rice in value terms.

** In these basic simulations, food crops supply elasticities are equal to 0,2. To see compare results to those presented in table 5.
*** Consumption = production + imports - losses – stock changes. Losses and stock changes as well as imports of secondary products are excluded in this table due to the low amount and for sake of simplicity.
**** See appendix a.1 table for periodic baseline data.